Intel® 7300 Chipset Memory Controller Hub (MCH)

Thermal/Mechanical Design Guide

September 2007

Document Number: 318086-001

Notice: This document contains information on products in the design phase of development. The information here is subject to change without notice. Do not finalize a design with this information.

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Revision History

Revision Number	Description	Date
001	• Initial release of the document.	September 2007

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1 Introduction

As the complexity of computer systems increases, so do the power dissipation requirements. Care must be taken to ensure that the additional power is properly dissipated. Typical methods to improve heat dissipation include selective use of ducting, and/or passive heatsinks.

The goals of this document are to:

- Outline the thermal and mechanical operating limits and specifications for the Intel® 7300 Chipset Memory Controller Hub (MCH).
- Describe a reference thermal solution that meets the specification of the Intel® 7300 Chipset Memory Controller Hub (MCH).

Properly designed thermal solutions provide adequate cooling to maintain the Intel® 7300 Chipset Memory Controller Hub (MCH) die temperatures at or below thermal specifications. This is accomplished by providing a low local-ambient temperature, ensuring adequate local airflow, and minimizing the die to local-ambient thermal resistance. By maintaining the Intel® 7300 Chipset Memory Controller Hub (MCH) die temperature at or below the specified limits, a system designer can ensure the proper functionality, performance, and reliability of the chipset. Operation outside the functional limits can degrade system performance and may cause permanent changes in the operating characteristics of the component.

The simplest and most cost effective method to improve the inherent system cooling characteristics is through careful chassis design and placement of fans, vents, and ducts. When additional cooling is required, component thermal solutions may be implemented in conjunction with system thermal solutions. The size of the fan or heatsink can be varied to balance size and space constraints with acoustic noise.

This document addresses thermal design and specifications for the Intel® 7300 Chipset Memory Controller Hub (MCH) components only. For thermal design information on other chipset components, refer to the respective component datasheet. For the PXH, refer to the *Intel® 6700PXH 64-bit PCI Hub/6702PXH 64-bit PCI Hub (PXH/PXH-V) Thermal/Mechanical Design Guidelines*. For the Intel® 631xESB/632xESB I/O Controller Hub, refer to the *Intel® 631xESB/632xESB I/O Controller Hub Thermal/ Mechanical Design Guidelines.*

Note: Unless otherwise specified, the term “MCH” refers to the Intel® 7300 Chipset Memory Controller Hub (MCH).

1.1 Definition of Terms

BGA	Ball grid array. A package type, defined by a resin-fiber substrate, onto which a die is mounted, bonded and encapsulated in molding compound. The primary electrical interface is an array of solder balls attached to the substrate opposite the die and molding compound.
BLT	Bond line thickness. Final settled thickness of the thermal interface material after installation of heatsink.
Intel® 631xESB/632xESB I/O Controller Hub	(formerly known as ESB2, Enterprise South Bridge 2) - The chipset component that integrates an Ultra ATA 100 controller, six Serial ATA host controller ports, one EHCI host controller, and four UHCI host controllers supporting eight external USB2.0 ports, LPC interface controller, flash BIOS interface controller, PCI interface controller, Azalia/AC'97 digital controller, integrated LAN controller, an ASF controller and a ESI for communication with the MCH. The Intel 631xESB/632xESB I/O Controller Hub component provides the data buffering and interface arbitration required to ensure that system interfaces operate efficiently and provide the bandwidth necessary to enable the system to obtain peak performance.
MCH	Memory controller hub. The chipset component contains the processor interface, the memory interface, the PCI Express* interface and the DMI interface.
ICH	I/O controller hub. The chipset component contains the MCH interface, the SATA interface, the USB interface, the IDE interface, and the LPC interface etc.
PXH	Intel® 6700PXH 64-bit PCI Hub. The chipset component performs PCI bridging functions between the PCI Express interface and the PCI Bus. It contains two PCI bus interfaces that can be independently configured to operate in PCI (33 or 66 MHz) or PCI-X* mode 1 (66, 100 or 133 MHz), for either 32 or 64 bit PCI devices.
PXH-V	Intel® 6702PXH 64-bit PCI Hub. The chipset component performs PCI bridging functions between the PCI Express interface and the PCI Bus. It contains one PCI bus interface that can be configured to operate in PCI (33 or 66MHz) or PCI-X mode 1 (66, 100 or 133 MHz).
IHS	Integrated Heat Spreader. Integrated part of the MCH package. It enhances dissipation of heat generated by the MCH die and provides interface surface between MCH die and cooling solution.
TIM	Thermal Interface Material. Thermally conductive material installed between two surfaces to improve heat transfer and reduce interface contact resistance.
T_{case_max}	Maximum die or IHS temperature allowed. This temperature is measured at the geometric center of the top of the package die or IHS.
T_{case_min}	Minimum die or IHS temperature allowed. This temperature is measured at the geometric center of the top of the package die or IHS.
TDP	Thermal design power. Thermal solutions should be designed to dissipate this target power level. TDP is not the maximum power that the chipset can dissipate.

1.2 Reference Documents

The reader of this specification should also be familiar with material and concepts presented in the following documents:

Document Title	Availability
Intel® 7300 Chipset Memory Controller Hub (MCH) Memory Controller Hub (MCH) Datasheeet	http://www.developer.intel.com/
Various system thermal design suggestions	http://www.formfactors.org
Intel 7300 Chipset Memory Controllwe Hub(MCH) Thermal Model (Flotherm*)	http://www.developer.intel.com/
Intel 7300 Chipset Memory Controllwe Hub(MCH) Mechanical Model (PRO/E*)	http://www.developer.intel.com/

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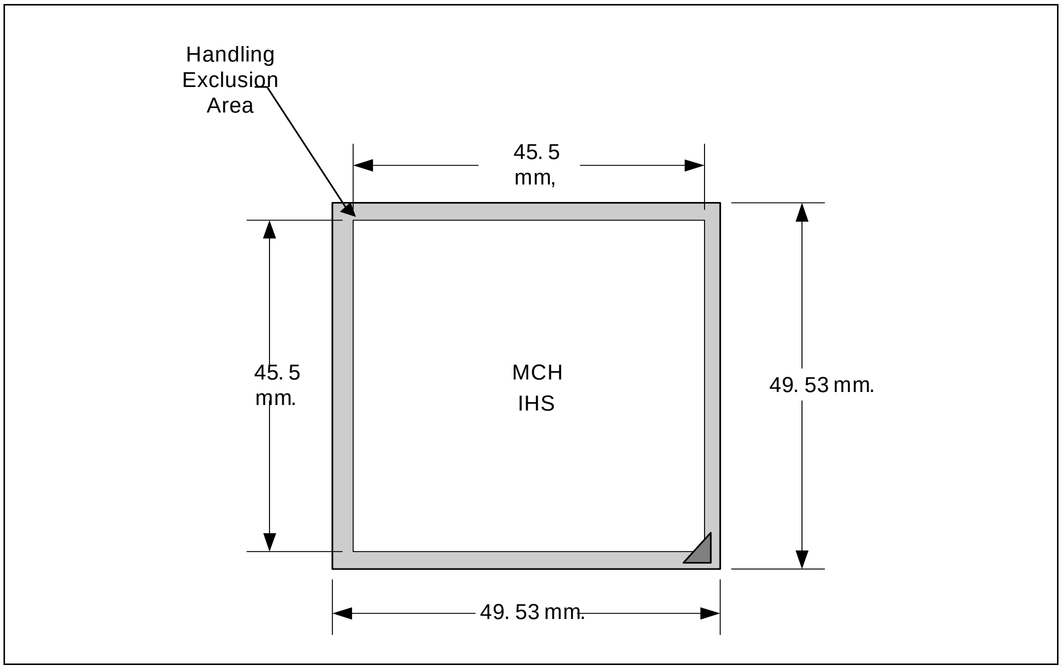
2 Packaging Technology

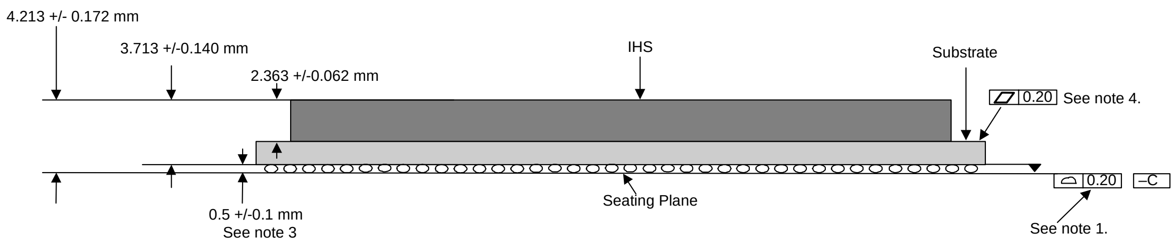
The Intel® 7300 Chipset Memory Controller Hub (MCH) consists of three individual components: the MCH, the Intel 631xESB/632xESB I/O Controller Hub and the Intel 6700PXH/6702PXH 64-bit PCI Hub. The Intel® 7300 Chipset Memory Controller Hub (MCH) components use a 49.5mm squared, 12-layer flip chip ball grid array (FC-BGA) package (see Figure 2-1, Figure 2-2 and Figure 2-3). For information on the PXH package, refer to the *Intel® 6700PXH 64-bit PCI Hub/6702PXH 64-bit PCI Hub (PXH/PXH-V) Thermal/Mechanical Design Guidelines*. For information on the Intel 631xESB/632xESB I/O Controller Hub package, refer to the *Intel® 631xESB/632xESB I/O Controller Hub Thermal/Mechanical Design Guidelines*.

Figure 2-1. MCH Package Dimensions (Top View)



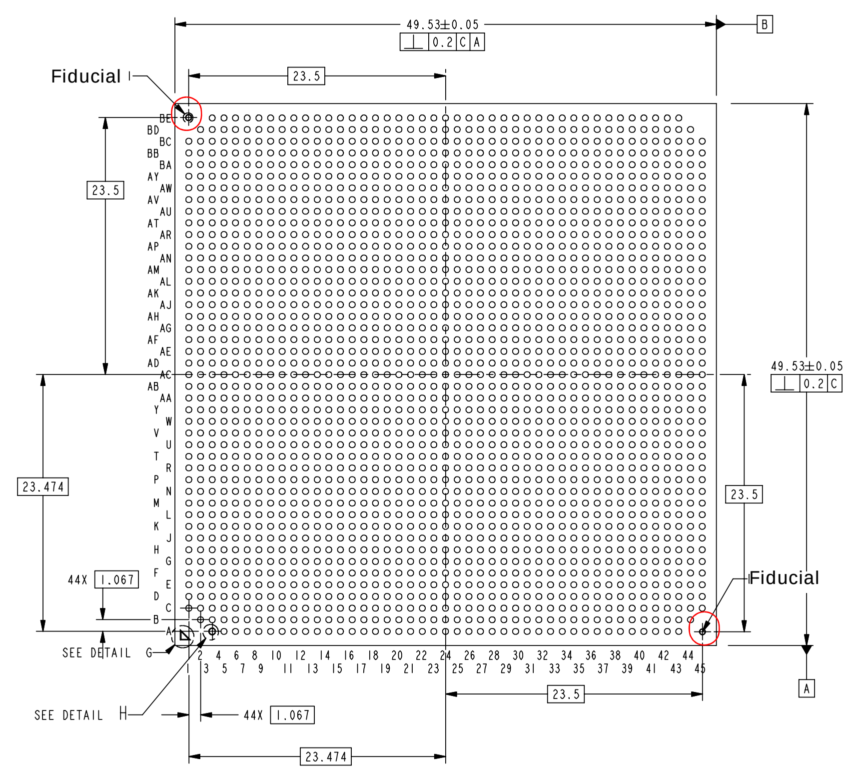
Note: All Dimensions are in Millimeter.

Figure 2-2. MCH Package Dimensions (Side View)



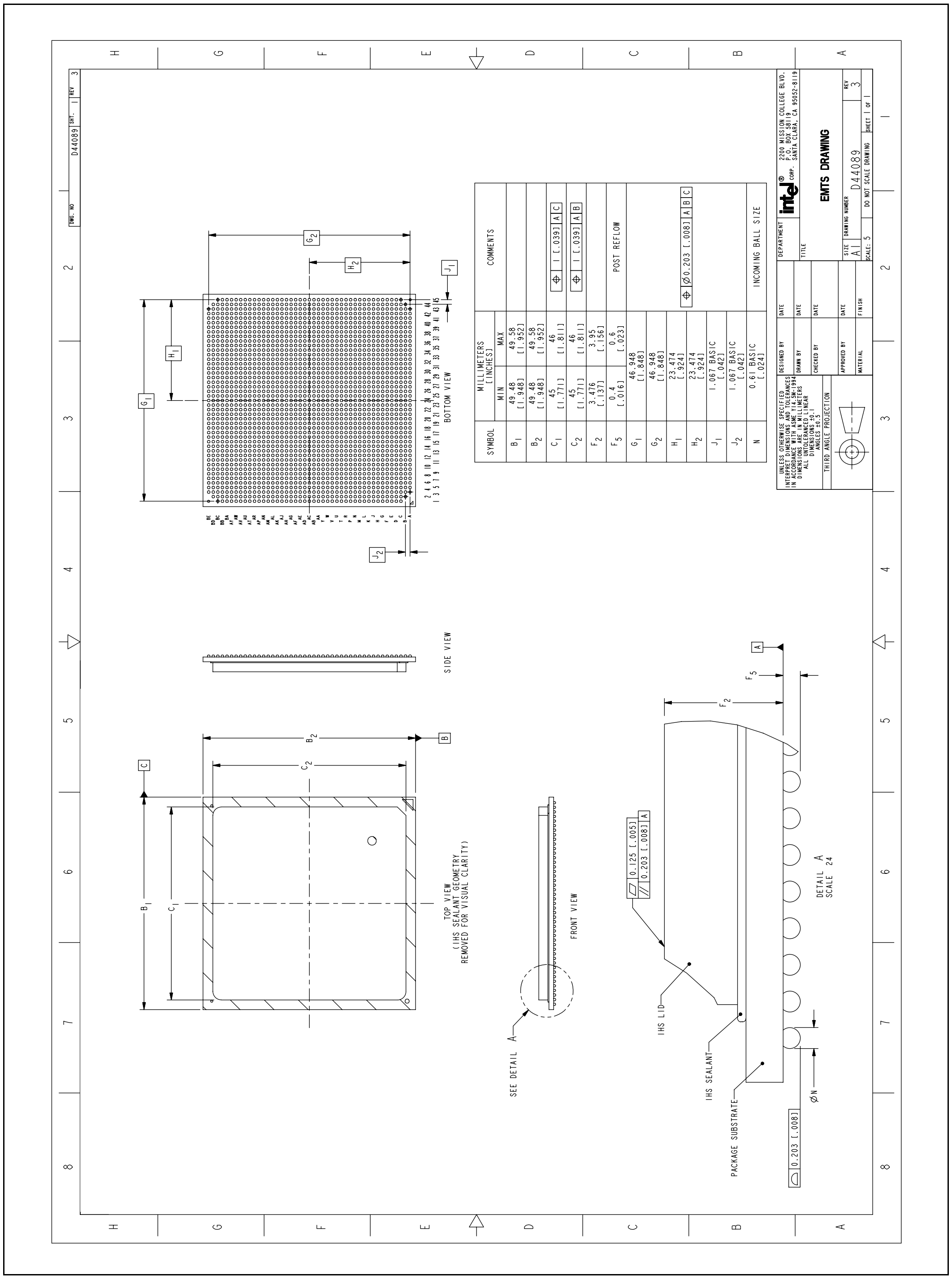
Notes:
1. Primary datum -C- and seating plan are defined by the spherical crowns of the solder balls (shown before motherboard attach)
2. All dimensions and tolerances conform to ANSI Y14.5M-1994
3. BGA has a pre-SMT height of 0.5mm and post-SMT height of 0.41-0.46mm
4. Shown before motherboard attach; FCBGA has a convex (dome shaped) orientation before reflow and is expected to have a slightly concave (bowl shaped) orientation after reflow

Figure 2-3. MCH Package Dimensions (Bottom View)



Notes:
1. All dimensions are in millimeters.
2. BGA pad diameter is 630 microns and BGA SRO diameter is 560 microns.
3. All dimensions and tolerances conform to ANSI Y14.5M-1994.
4. 2 dots on the diagonally opposite corners are fiducials.
5. 2 dots on the diagonally opposite corners are fiducials.

Figure 2-4. Intel 7300 Chipset Memory Controller Hub (MCH) Package Drawing



2.1 Package Mechanical Requirements

The Intel® 7300 Chipset Memory Controller Hub (MCH) package has an IHS which is capable of sustaining a maximum static normal load of 15-lbf. This mechanical load limit must not be exceeded during heatsink installation, mechanical stress testing, standard shipping conditions and/or any other use condition.

Notes:

1. The heatsink attach solutions must not include continuous stress onto the chipset package with the exception of a uniform load to maintain the heatsink-to-package thermal interface. And, this uniform load should not exceed the maximum allowable static normal compressive load of 15 lbf.
2. These specifications apply to uniform compressive loading in a direction perpendicular to the IHS top surface.
3. These specifications are based on limited testing for design characterization. Loading limits are for the package only.

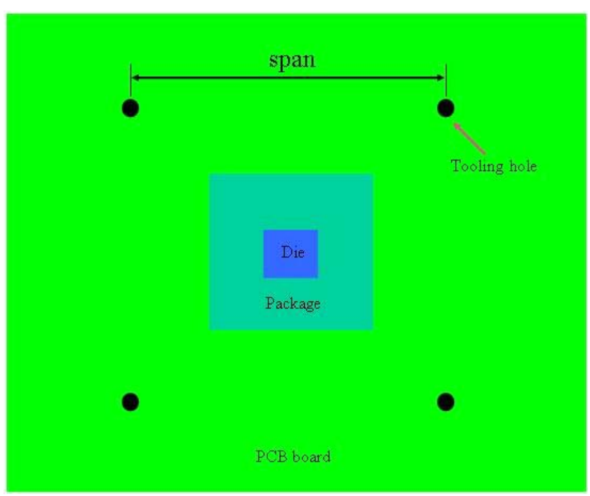
Table 2-1. Maximum Design limits[1]

Attributes	Maximum design limit by board thickness, 93mil (2.36mm)	Comments
Static Compressive	15lbf with 55mm span[1] (without back plate) 20lbf with Pb-free (with back plate)	Meet Intel 7300 Chipset Memory Controller Hub (MCH) reliability Requirement using PbSn (worse case). Lead Free has better performance than PbSn.
Dynamic Bend and Dynamic Compressive	1300 με	

Notes:
1. 1. These maximum design limits are for 1.067 ball pitch with package form factor less than 49.53 mm sq, 3 corner BGA balls depopulated and 12 BGAs NCTF at each corner

See Figure 2-5 for span definition.

Figure 2-5. Span definition for Static Compressive Test



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3 Thermal Simulation

Intel provides thermal simulation models of the Intel® 7300 Chipset Memory Controller Hub (MCH) and associated user's guides to aid system designers in simulating, analyzing, and optimizing their thermal solutions in an integrated, system-level environment. The models are for use with the commercially available Computational Fluid Dynamics (CFD)-based thermal analysis tool FLOTHERM* (version 5.1 or higher) by Flomerics, Inc. These models are also available in IcePak* (version 4.2 or higher) format. Contact your Intel field sales representative to order the thermal models and user's guides.

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4 Thermal Specifications

4.1 Thermal Design Power (TDP)

Analysis indicates that real applications are unlikely to cause the MCH component to consume maximum power dissipation for sustained time periods. Therefore, in order to arrive at a more realistic power level for thermal design purposes, Intel characterizes power consumption based on known platform benchmark applications. The resulting power consumption is referred to as the Thermal Design Power (TDP). TDP is the target power level to which the thermal solutions should be designed. TDP is not the maximum power that the chipset can dissipate.

FC-BGA packages have poor heat transfer capability into the board and have minimal thermal capability without a thermal solution. Intel recommends that system designers plan for a heatsink when using the Intel® 7300 Chipset Memory Controller Hub (MCH).

4.2 Die Case Temperature

To ensure proper operation and reliability of the Intel® 7300 Chipset Memory Controller Hub (MCH), the case temperatures on top of IHS must be at, or between, the maximum operating temperature, as specified in the *Intel® 7300 Chipset Memory Controller Hub (MCH Datasheet*. System and/or component level thermal solutions are required to maintain these temperature specifications. Refer to Section 5 for guidelines on accurately measuring package case temperatures.

Table 4-1. Intel® 7300 Chipset Memory Controller Hub (MCH) Thermal Specifications

Parameter	Value	Notes
TDP	47W	At 4 Memory Channels
TDP	40W	At 2 Memory Channels
Idle Power	33W	At 4 Memory Channels
Idle Power	27W	At 2 Memory Channels

Note: These specifications are based on post-silicon estimates and simulations. These specification will be updated with characterized data from production silicon measurements at a later date.

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5 Thermal Metrology

The system designer must make temperature measurements to accurately determine the thermal performance of the system. Intel has established guidelines for proper techniques to measure the MCH case temperatures. Section 5.1 provides guidelines on how to accurately measure the MCH case temperatures. Section 5.7 contains information on running an application program that will emulate anticipated maximum thermal design power.

5.1 MCH Case Temperature Measurements

Intel® 7300 Chipset Memory Controller Hub (MCH) cooling performance is determined by measuring the case temperature using a thermocouple. For case temperature measurements, the attaching method outlined in this section is recommended for mounting a thermocouple.

Special care is required when measuring case temperature (Tc) to ensure an accurate temperature measurement. Thermocouples are often used to measure Tcase. When measuring the temperature of a surface that is at a different temperature from the surrounding local ambient air, errors may be introduced in the measurement. The measurement errors can be caused by poor thermal contact between the thermocouple junction and the surface of the integrated heat spreader, heat loss by radiation, convection, by conduction through thermocouple leads, or by contact between the thermocouple cement and the heatsink base. To minimize these measurement errors, the approach outlined in the next section is recommended.

Note: *Drawings and pictures in this section do not represent a specific Intel® 7300 Chipset Memory Controller Hub (MCH) package. Intel® 7300 Chipset Memory Controller Hub (MCH) should follow the same methodology.*

The process described in this chapter is untested.

This study was done using BTX boards and assumed similar planarity for ATX boards. The groove drawing requires the machinist validate Z height at the package I.H.S. center and the edge where the groove exits. The Z height will need to be interpolated to keep the groove depth consistent after the parts are soldered to the board. This extra step is required due to planarity issues when the part is installed on the MB. There is also a drawing of a special fixture plate to mount a motherboard for milling parts after they are soldered to the motherboard. The plate should have a FLAT bottom surface. After installing the HEX nuts the top surface of the nuts should be machined down about .010 inches to insure the motherboard is planer to the base of the plate for machining the I.H.S.

5.2 Objective

This procedure will provide all necessary information required for attaching an Omega (36 gage) Type “T” Thermocouple (TC) to a FCBGA7 Thermal test Board MCH used for T-case measurements. It is for an Omega 36 gage thermocouple with a solder attach method.

5.3 Scope

This procedure covers I.H.S preparation including the machined groove, TC solder attach process, and post-installation verification/maintenance. This procedure also covers all required tools and equipment for proper TC attach.

5.4 Definitions

Item	Definition
TC	Thermocouple
TTV	Thermal Test Vehicle
MTF	Material Transfer Form
IPA	Isopropyl Alcohol
DMM	Digital Multi Meter
IHS	Integrated Heat Spreader
CPU	Central processing Unit

Supporting Test Equipment

Item	Part Num.	Qty	Description
Measurement & Output			
Microscope	SZ-40	1	Olympus Light microscope or equivalent.
DMM	79 Series or equivalent	1	Digital Multi Meter for resistance measurements.
Test Fixture(s)			
Special Modified Tip Solder Block Fixture	Weller SP40L solder tool	1	40W 120V~60Hz modified soldering iron
Misc. Hardware			
Loctite 498	49850	1	Adhesive
Loctite 7452	18490	1	Adhesive Accelerator
Solder	52124	1	Indium Solder 57BI/42SN/1AG (0.010” DIA)
Flux	5RMA	1	Indium Solder Flux
Kapton Tape	N/A	1	For holding TC in place
Isopropanol	N/A	1	Industrial Alcohol
Omega 36 TC	OSK2K1280/5SRTC-TT-T-36-72	1	“T” Type Thermocouple.
Tweezers	N/A	1	Tool need to handle parts under microscope
Blade	N/A	1	Tool need to shave components above HIS
Cleaning wipes and swabs	N/A		As needed

Note: Refer to the table in Appendix A for additional supplier and supplies ordering information.

5.5 Safety Equipment / Requirements

Item / Course	Description	Course / Part / Doc Number
Equipment		
Safety Glasses	Cutting IHS groove	
Gloves	For handling hot devices	
Gloves	Chemical handling	
Training		
N/A	Training can be provided by appointment only.	Greg Carlson

5.6 Procedure

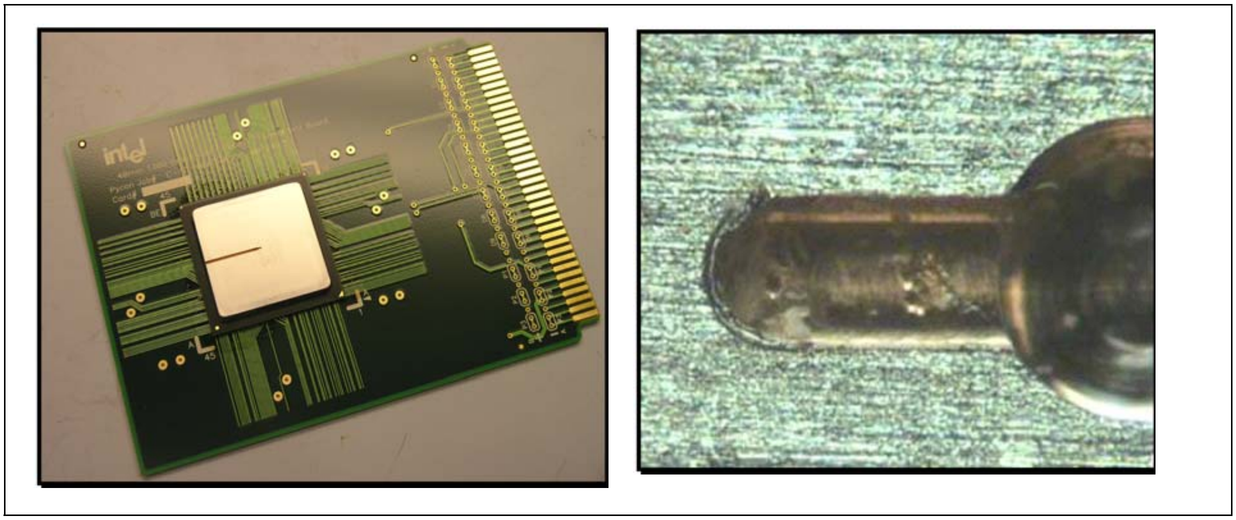
In order to accomplish the objective, the following steps will be required.

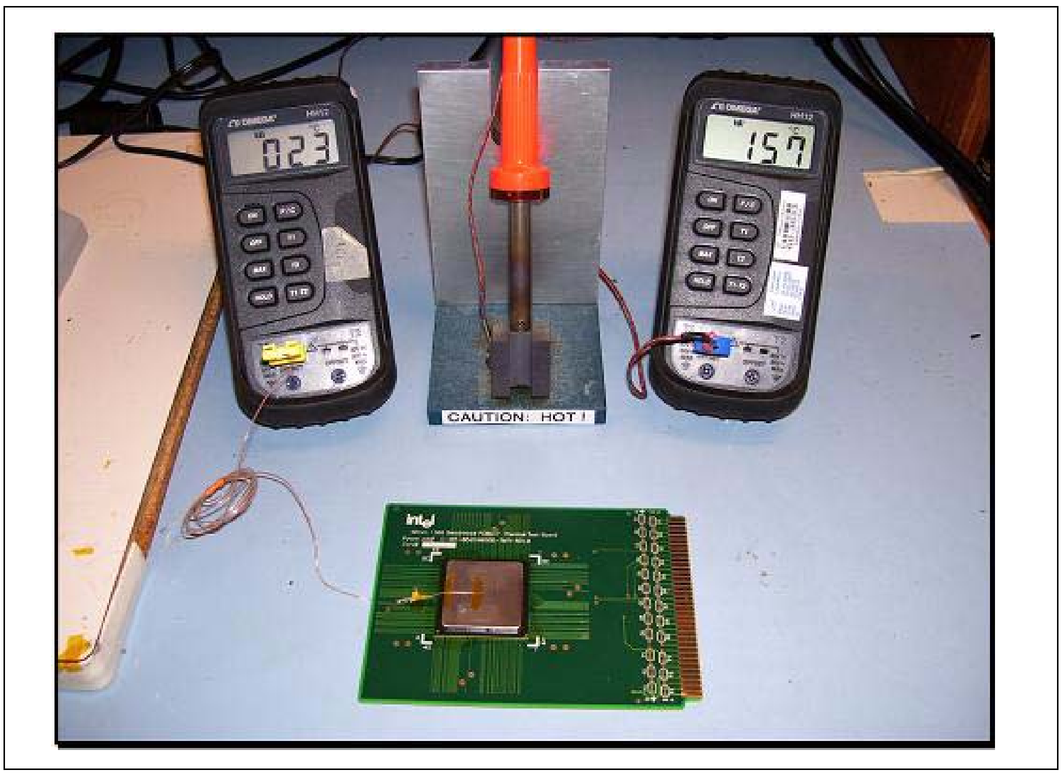
1. TMTV/CPU machining for TC attach.
2. TC conditioning and preparation.
3. TC attach to the I.H.S.
4. Soldering process.
5. Cleaning & completion of the TC installation.

5.6.1 Acquire TTV / MCH Groove Drawing for Machining Details

1. Arrange for a qualified machine shop to modify the devices with the groove for the thermocouple. Refer to the drawing at the back of this procedure (Appendix B).
2. The groove is to be cut per the latest Intel approved drawing. Cut direction is to be specified on the drawing. Mark one unit with the groove orientation before sending to machine shop for cutting of I.H.S. groove to insure the parts are cut correctly.
3. Inspect parts for compliance to drawing specifications before accepting them from the machine shop.
4. Clean the groove channel with IPA and a cloth removing all residues prior to attaching the thermocouple (see Figure 5-1).

Figure 5-1. I.H.S. Groove with tip (I.H.S. Center) Detail



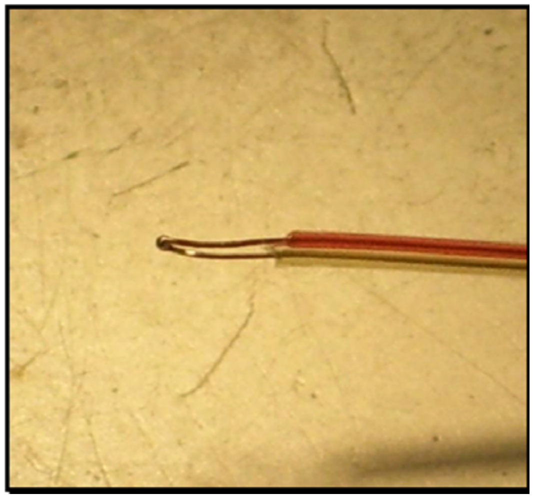


Note: You should turn the solder melt fixture on to preheat the copper heater block. Insure the heater temperature is set hot enough to raise the I.H.S. temp to +150/-160°C. Damage to the MCH/CPU package could occur if it’s junction temp exceeds 155°C

5.6.2 TC Conditioning and Preparation

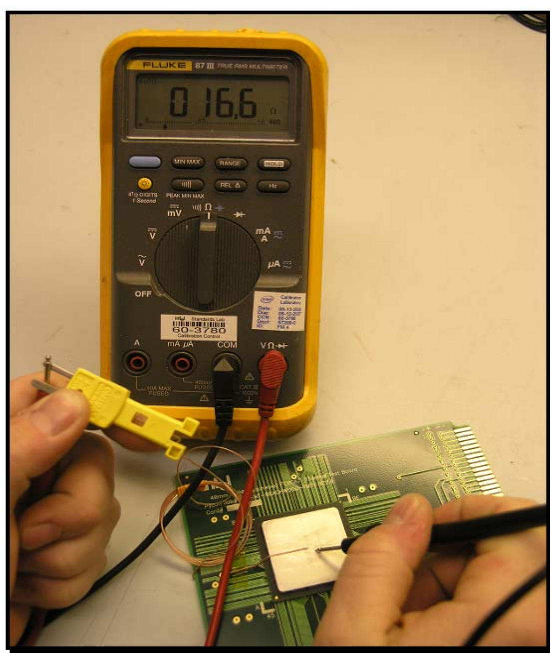
1. Place the thermocouple under the microscope and inspect it for even wire length, verify the insulation meets minimum quality requirements (See Figure 5-2).

Figure 5-2. A Good Quality TC Bead and Insulation Cut Example



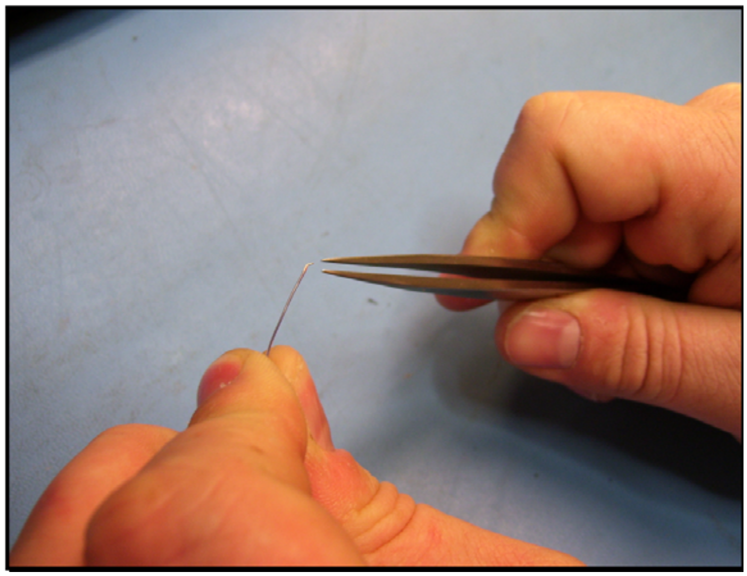
2. Measure the TC resistance by shorting both connector probes with one DMM probe and the tip of TC to the other DMM probe, the measurement should be about 3 Ohms for 36 gage, and about 6 ohms for 40 gage wire (See Figure 5-3).

Figure 5-3. Testing TC Continuity



3. Straighten roughly 37mm (1 1/2 inches) of the tip of the thermocouple wire.
4. Using a microscope and tweezers, slightly bend the TC bead (10 degrees down – See Figure 5-4). This helps keep the bead seated on the bottom surface of the groove after installation.
   — A slight bend to the tip will help keep the TC bead on the bottom of the I.H.S. groove.

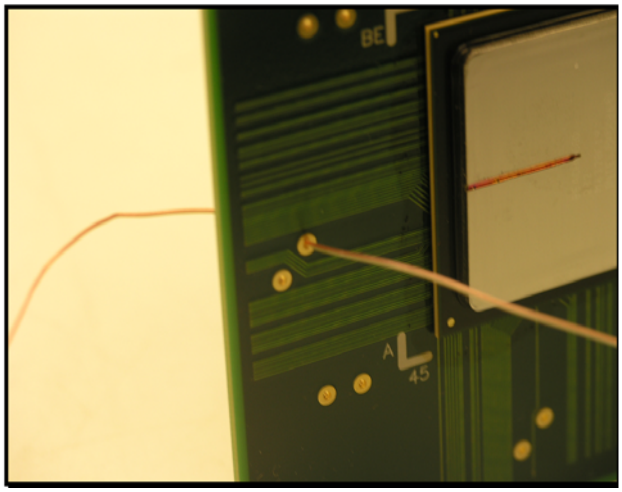
Figure 5-4. Slight Bend to the Tip



5.6.3 Secure the TC to the I.H.S

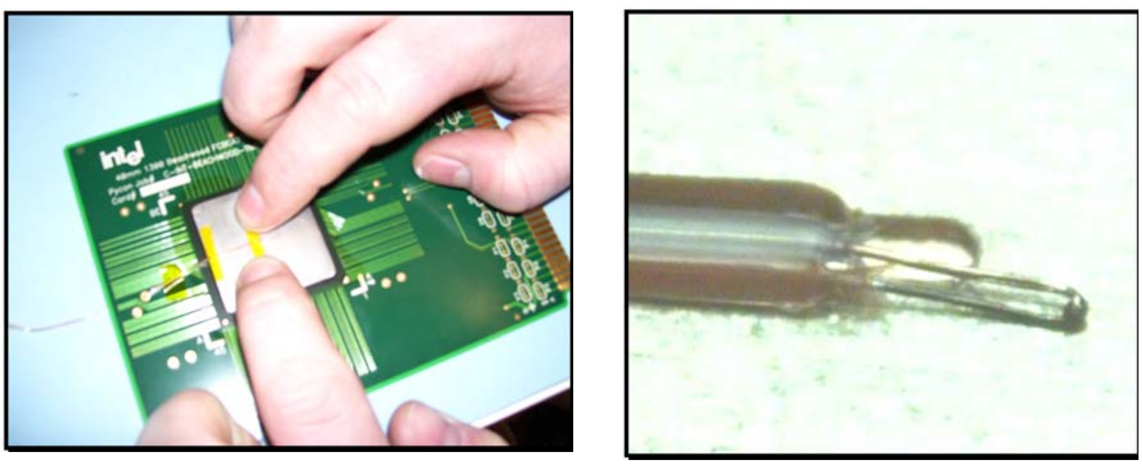
1. Lift the wire at the middle of the channel with tweezers and bend the front of wire to place the thermocouple bead in the channel ensuring the tip is in contact at the end of the groove in the I.H.S.
   — Leading TC wire through passage in board will add reinforcement to keep the wire from pulling from I.H.S. after solder attach.

Figure 5-5. Reinforcing the TC Wire



2. Place the TC wire inside the channel and let the exposed wire extend slightly over the end of groove (See Figure 5-6 right).
3. Bend the wire at the edge of the I.H.S. channel and secure it in place using Kapton tape (See Figure 5-6 left).

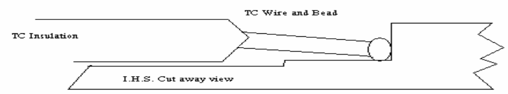
Figure 5-6. Securing the TC to the Edge of the I.H.S



4. Verify under the microscope that the TC bead is still slightly bent, if not, use a fine point tweezers to put a slight bend on the tip.

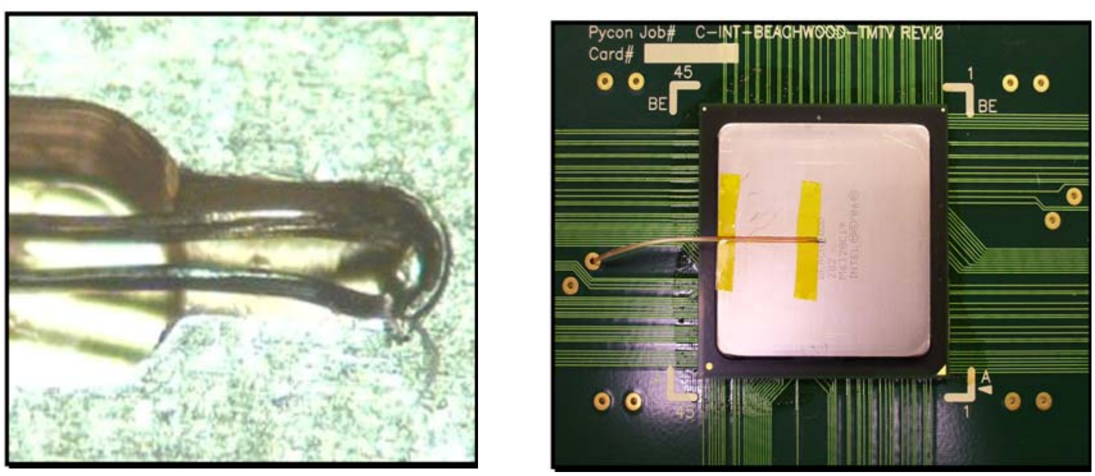
Note: **The purpose of this step is to ensure the TC tip is in contact with the bottom of groove (see Figure 5-7).**

Figure 5-7. TC Bead Placed in Bottom Corner of the I.H.S. Groove



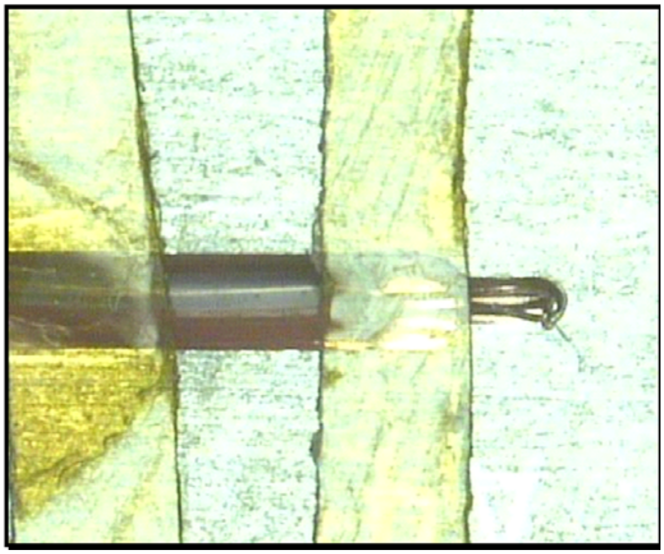
5. Place the device under the microscope to continue with the process.
6. Using tweezers or a finger, slightly press the wire down inside the groove for about 5mm from tip and place small piece of Kapton tape to hold the wire inside the groove (See Figure 5-8) (use the microscope to perform this task).
   — The bead is placed into the bottom of the groove and a small piece of tape is installed to secure it.

Figure 5-8. Securing the Wire



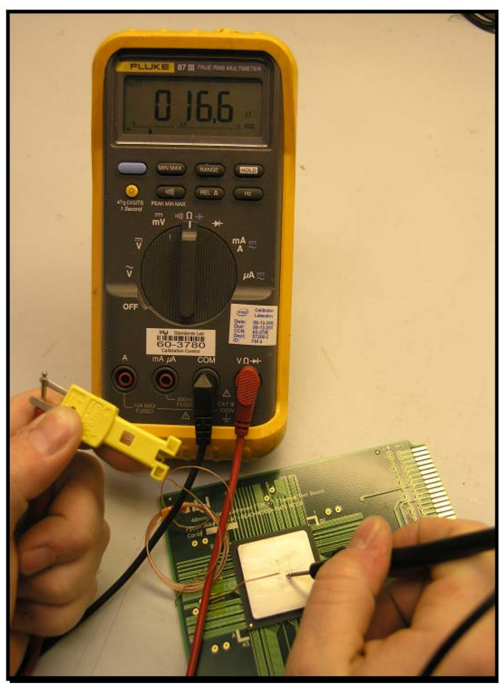
7. Place a second small piece of Kapton tape on top of the I.H.S. where it narrows at the tip. This tape will create a solder dam and keep solder from flowing down the I.H.S. groove during the melting process. (See Figure 5-9).
   — Kapton tape is placed at the edge where the groove narrows to retain the TC tip and keep solder from flowing down the groove during the melt process.

Figure 5-9. Creating a Solder Dam with Kapton Tape



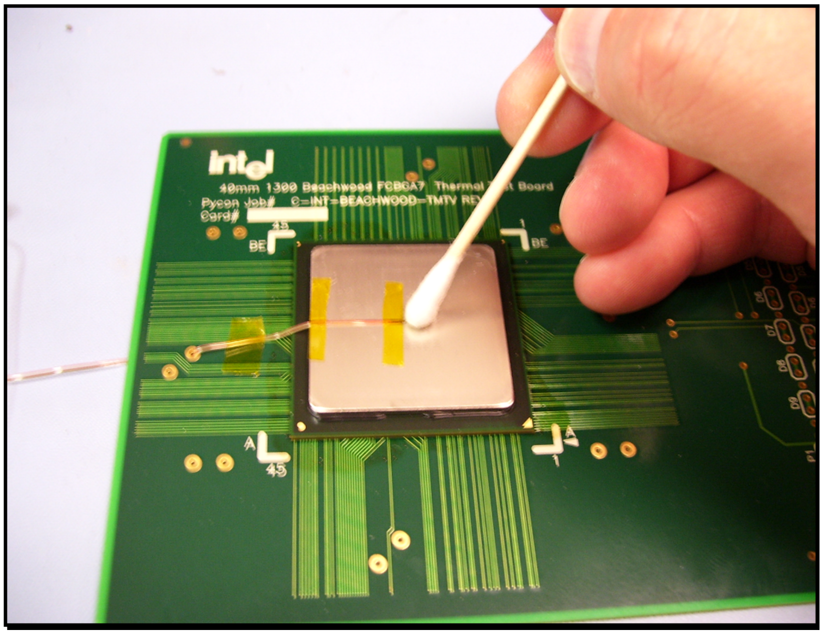
8. Measure resistance from the TC connector (hold both wires to a DMM probe) to the I.H.S. surface, this should display the same value as read during TC conditioning. This step insures the bead is still making good contact to the I.H.S. (See Figure 5-10).

Figure 5-10. Measuring TC to I.H.S. Continuity



9. Using a fine point device such as a toothpick, place a small amount of Indium paste flux on the TC bead (see Figure 5-11).

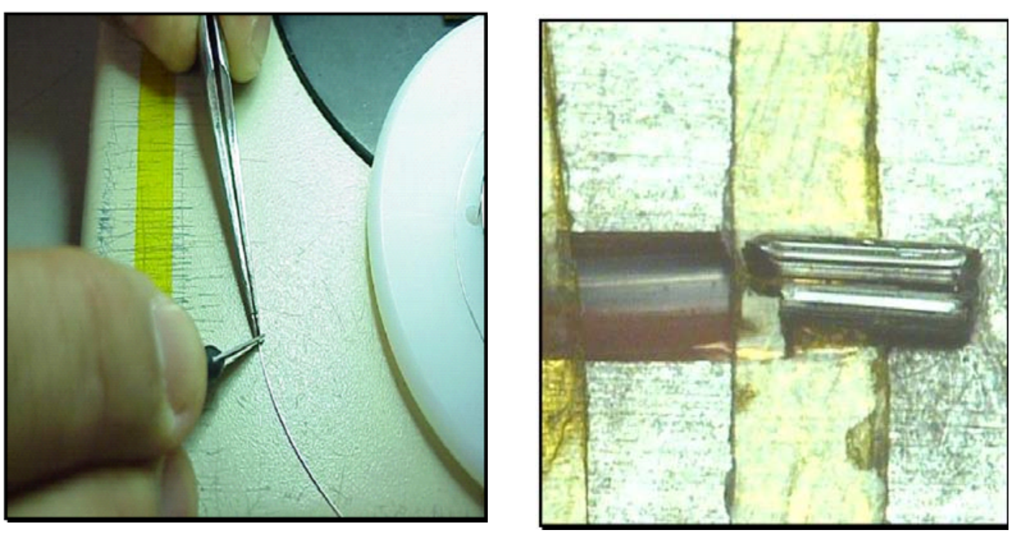
Figure 5-11. Adding Flux to the Bead for Soldering



Note: **Be careful to keep the solder flux from spreading on the I.H.S. surface or down the channel. It should be contained to the bead area and only the tip (narrow section of the groove). This keeps the solder from flowing onto the top of the device or down the channel to the insulation area.**

10. Cut two small pieces of Solder about (1/16” or 0.065”) long from the roll using tweezers to hold the solder, and blade to cut. Place the two pieces of solder in parallel, right on top of the TC bead (See Figure 5-12).

Figure 5-12. Solder Placed on TC Bead Area for Melting



11. Verify electrical connectivity of the TC using the DMM again and measure resistance as in step 8 (result should be the same). This is to insure the bead position is maintained during flux and solder installation.

5.6.4 Solder Process

1. Turn ON the Solder Block station and let it heat up to 170 degrees ±5 (Celsius).

Note: The heater block temperature must be set at a greater temp to ensure that the solder on the I.H.S. can reach 150-155°C. Be sure to monitor the TC meter when waiting for solder to flow. Damage to the package may occur if a temperature of 155°C is exceeded on the I.H.S.

2. Attach the tip of the TC to the solder block (perform this before turning on the solder station switch) and connect to a TC meter to monitor the temperature of the block (See Figure 5-13).
3. Connect the (TC being installed) to a second TC meter to monitor the I.H.S. temperature and make sure this doesn't exceed **155 °C** degrees at any time during the process.
   — Device in place, 2 temp monitoring meters, and heater block fixture. The heater block is currently reading 157°C and the TC inside I.H.S. is reading 23°C.

Figure 5-13. Monitoring Temperatures

4. Place the solder fixture on the I.H.S. device (see Figure 5-14).

Caution: Don't touch the copper block at any time; it is very hot!

Note: The TC being installed needs to reach above +150°C but not greater than +155°C for the solder to melt.

5. Move a magnified lens light close to the device to get a better view when the solder starts melting. Manually assist this if necessary as the solder sometimes tends to move away from the end of the groove. **Monitor the**

TC inside the I.H.S. until the temp reaches ~150 °C. The solder will flow between this time and ~155 °C. Do not exceed 155 °C. Use fine tip tweezers to push solder into the end of groove until a solder ball is built up (See Figure 5-14).

Figure 5-14. Observing the Solder Melting

6. Lift the solder block and magnified lens, quickly rotate the device 90 degrees clockwise and use the back side of the tweezers to press down on the solder. This will force out excess solder. (see Figure 5-15)

Note: Use gloves for this to avoid burning the fingertips.

Figure 5-15. Flatten the Solder and Remove Excess Material

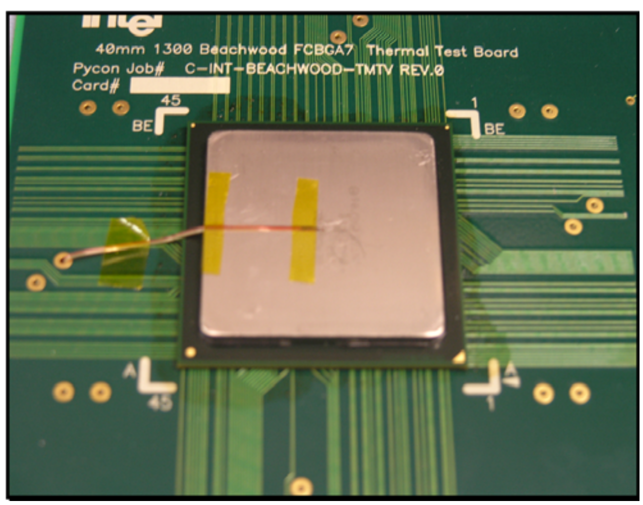
7. Cool down the device with compressed air while monitoring the temperature until it drops below 70 degrees before moving it to the microscope for the final steps.

5.6.5 Cleaning and Completing the TC Installation

1. Remove the Kapton tape with tweezers (avoid damaging the wire insulation) and straighten the wire to insert the remaining portion in the groove for the final gluing process.

Note: The wire needs to be straight so it doesn't sit above the I.H.S. surface at any time (See Figure 5-16).

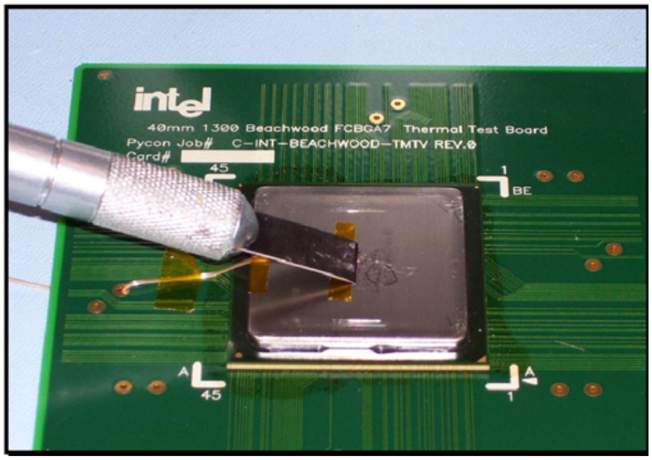
Figure 5-16. Placing the Wire



Note: Always insure tools are very sharp and free from any burrs that may scratch the I.H.S. surface. It is a good practice to minimize any surface scratching or other damage during this process.

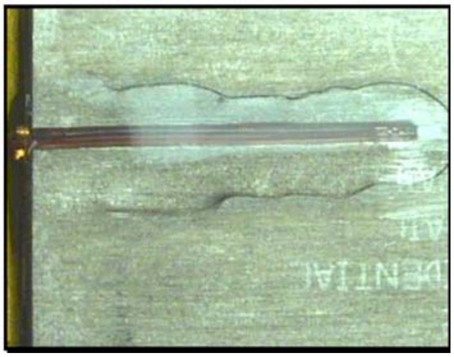
2. Using a blade, carefully shave the excess solder above the IHS surface. Only shave in one direction until solder is flush with the groove surface (See Figure 5-17).
   — Shaving excess solder to insure the I.H.S. surface is flat and will mate properly with the heat sink surface. Scratches and protrusions may impact the thermal transfer from I.H.S. to the heat sink under test.

Figure 5-17. Shaving Excess Solder



3. Clean the surface of the I.H.S. with Alcohol and wipes, use compressed air to remove any remaining contaminants.
4. Fill the rest of the groove with Loctite 498 Adhesive. Verify under the microscope that the TC wire is below the surface along the entire I.H.S. groove (See Figure 5-18).

Figure 5-18. Glue Remaining TC Wire into the I.H.S. Groove.



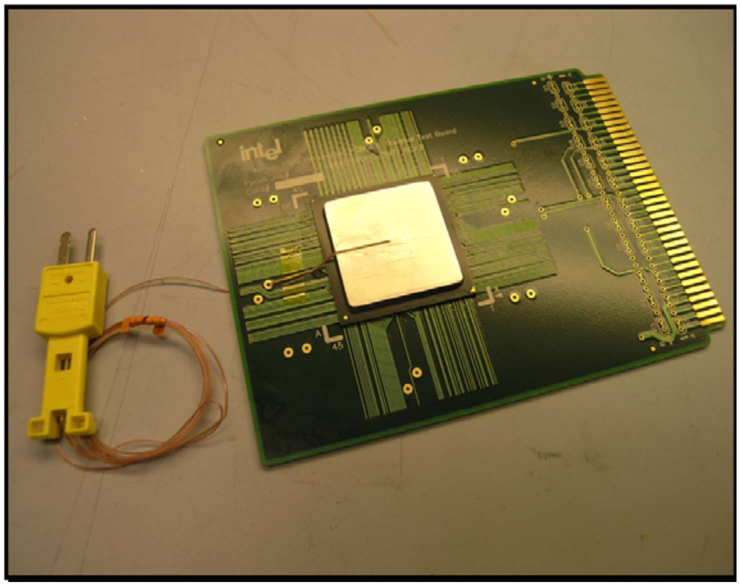
5. Using a blade, carefully shave any Loctite left above the IHS surface; take into_consideration instructions from step 2.

Note: The adhesive shaving process should be performed when the glue is partially cured but still soft (about 1 hour after applying). This will keep the adhesive surface flat and smooth with no pits or voids. If you have void areas in the groove, refill them and shave the surface a second time.

6. Clean the I.H.S. surface with Alcohol and keep the TC wire properly managed to avoid insulation damage kinks and tangling.

7. Once again, measure resistance from the TC connector (hold both wires to a DMM probe) to the I.H.S. surface, this should display the same value as read during TC conditioning. This step insures the bead is still making good contact to the I.H.S. after attachment is complete.

Figure 5-19. Completed Installation



5.7 Power Simulation Software

The power simulation software is a utility designed to dissipate the thermal design power on a Intel® 7300 Chipset Memory Controller Hub (MCH) chipset MCH when used in conjunction with the Tigerton processor (1067 MHz). The combination of the above mentioned processor(s) and the higher bandwidth capability of the Intel® 7300 Chipset Memory Controller Hub (MCH) chipset enable higher levels of system performance. To assess the thermal performance of the chipset MCH thermal solution under “worst-case realistic application” conditions, Intel is developing a software utility that operates the chipset at near worst-case thermal power dissipation. The power simulation software being developed should only be used to test thermal solutions at or near the thermal design power. Real world applications may exceed the thermal design power limit for transient time periods. For power supply current requirements under these transient conditions, please refer to each component's datasheet for the ICC (Max Power Supply Current) specification. Contact your Intel field sales representative to order the power utility and user's guides.

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6 Reference Thermal Solution

Intel has developed a reference thermal solution to meet the cooling needs of the Intel® 7300 Chipset Memory Controller Hub (MCH) under operating environments and specifications defined in this document. This chapter describes the overall requirements for the reference thermal solution including critical-to-function dimensions, operating environment, and validation criteria. Other chipset components may or may not need attached thermal solutions, depending on your specific system local-ambient operating conditions. For information on the PXH/PXH-V, refer to thermal specification in the *Intel® 6700PXH 64-bit PCI Hub/6702PXH 64-bit PCI Hub (PXH/PXH-V) Thermal/Mechanical Design Guidelines*. For information on the ICH7, refer to thermal specification in the *Intel® 631xESB/632xESB I/O Controller Hub Thermal/Mechanical Design Guidelines.*

6.1 Operating Environment

6.1.1 High Ambient Thermal Boundary Condition

The reference thermal solution was designed assuming a maximum local-ambient temperature of 46.5 °C. The minimum recommended airflow velocity through the cross-section of the heatsink fins is 680 linear feet per minute (lfm) or 3.4 meters per second (m/s) for 4U and 4U+ system. The thermal solution is designed to pass the thermal envelop with the altitude at or below 900 meters. The approaching airflow temperature is assumed to be equal to the local-ambient temperature. The thermal designer must carefully select the location to measure airflow to obtain an accurate estimate. These local-ambient conditions are based on a 35 °C external-ambient temperature at sea level. (External-ambient refers to the environment external to the system.

6.1.2 Acoustic Thermal Boundary Conditions

The reference thermal solution was designed assuming a maximum local-ambient temperature of 40.1 °C. The minimum recommended airflow velocity through the cross-section of the heatsink fins is 680 linear feet per minute (lfm) or 1.5 meters per second (m/s) for 4U and 4U+ system. The thermal solution is designed to pass the thermal envelop with the altitude at or below 900 meters. The approaching airflow temperature is assumed to be equal to the local-ambient temperature. The thermal designer must carefully select the location to measure airflow to obtain an accurate estimate. These local-ambient conditions are based on a 25 °C external-ambient temperature at sea level. (External-ambient refers to the environment external to the system.

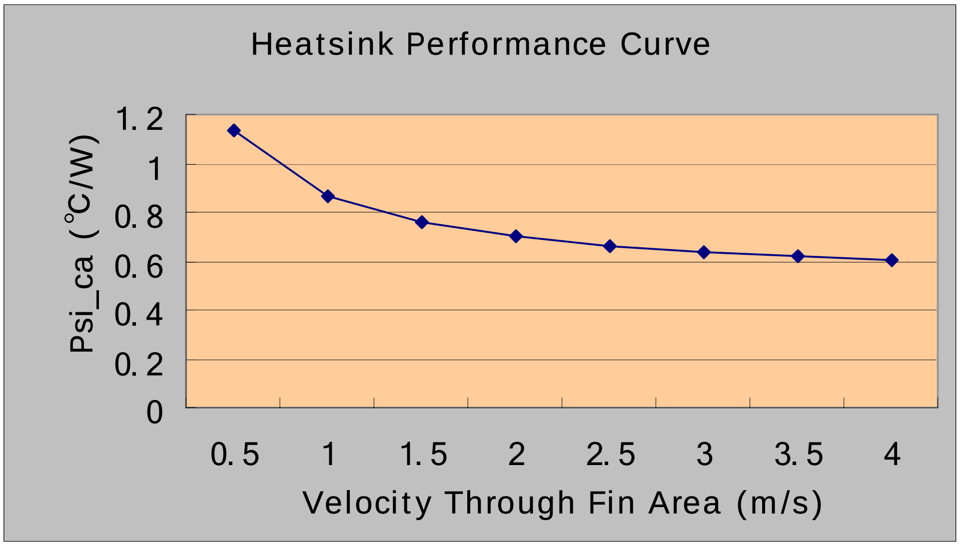
Table 6-1. High Ambient and Acoustic Thermal Boundary Conditions

	High Ambient	Acoustic
System Ambient	35 °C	25 °C
Local Ambient	46.5 °C	40.1 °C
Altitude	900m	900m
Air flow velocity	3.4 m/sec	1.5 m/sec

6.2 Heatsink Performance

Figure 6-1 depicts the measured thermal performance of the reference thermal solution versus approaching air velocity. Since this data was simulated with altitudes at 900 meters level, a correction factor would be required to estimate thermal performance at customized altitudes.

Figure 6-1. Simulated Heatsink Thermal Performance versus Approaching Velocity



6.3 Mechanical Design Envelope

While each design may have unique mechanical volume and height restrictions or implementation requirements, the height, width, and depth constraints typically placed on the Intel® 7300 Chipset Memory Controller Hub (MCH) thermal solution are shown in Figure 6-2.

When using heatsinks that extend beyond the chipset MCH reference heatsink envelope, any motherboard components placed between the heatsink and the motherboard cannot exceed the keepout area shown in Figure 6-2 and Figure 6-3.

Note: The mechanical height, width and depth of heatsink are specified in Figure 6-2 and Figure 6-3. Please refer to the dimensions and notes in these figures.

6.4 Board-Level Components Keepout Dimensions

The location of hole patterns and keepout zones of the motherboard for the reference thermal solution are shown in Figure 6-2 and Figure 6-3.

Figure 6-2. Motherboard Primary Side Keepout

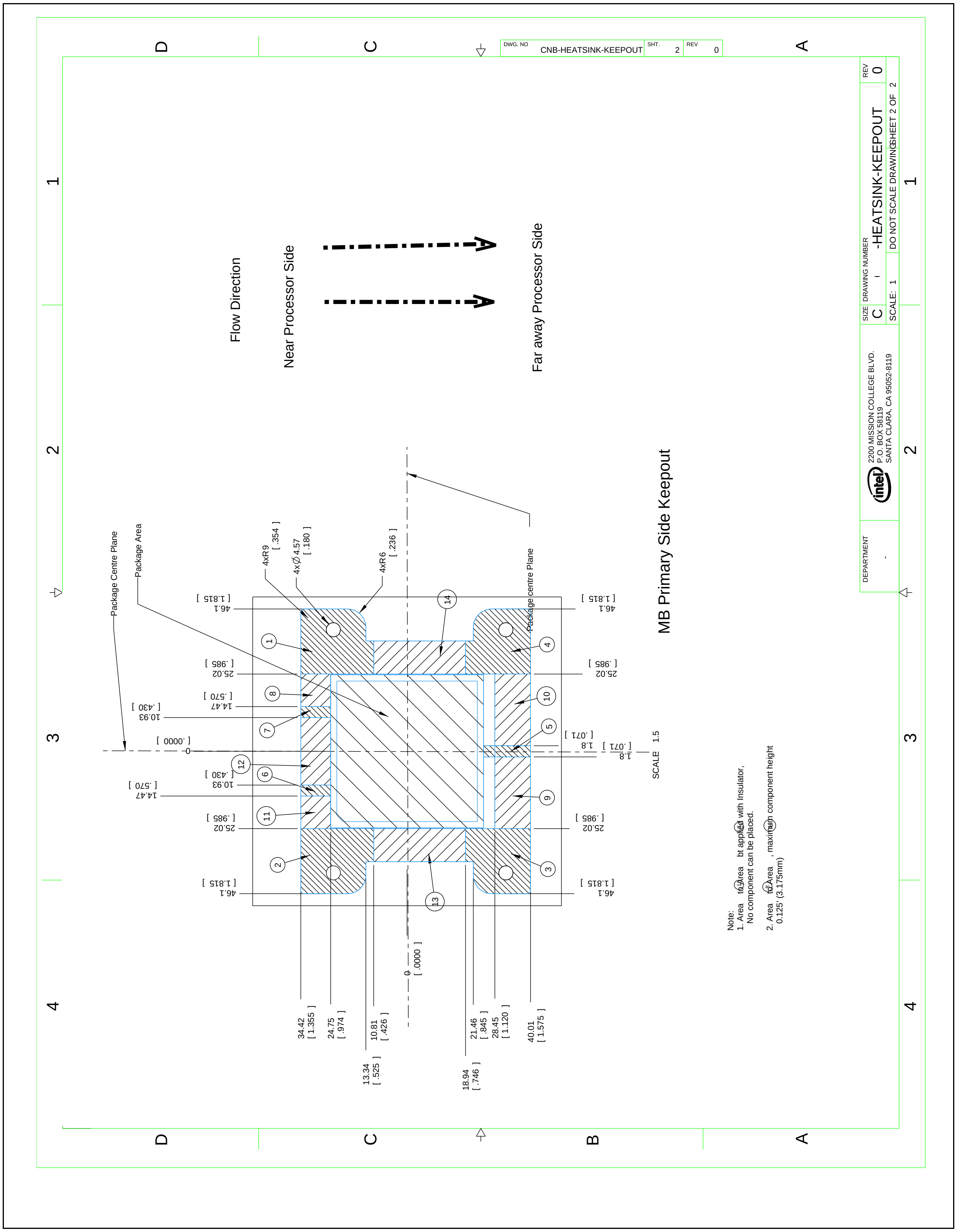
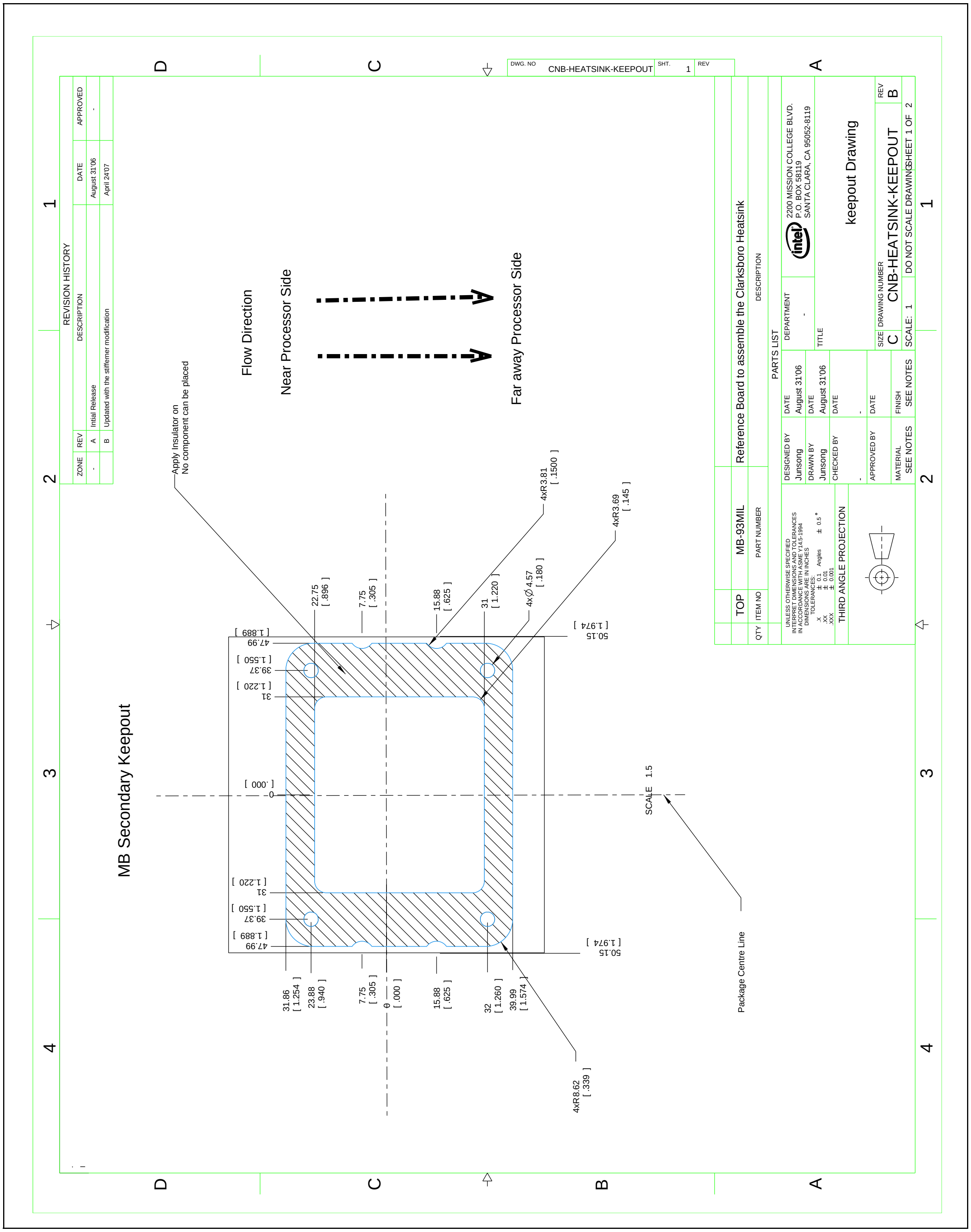


Figure 6-3. Motherboard Secondary Side Keepout



6.5 Intel® 7300 Chipset Memory Controller Hub (MCH) Heatsink Thermal Solution Assembly

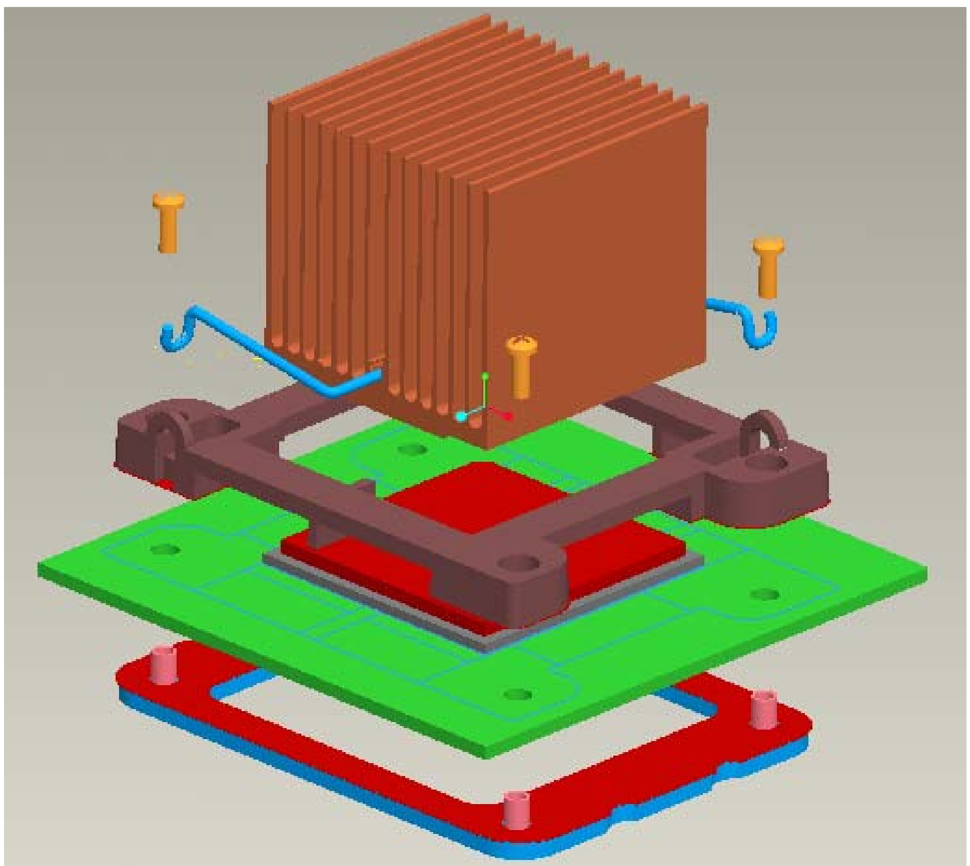
The reference thermal solution for the Intel® 7300 Chipset Memory Controller Hub (MCH) (Intel 7300 MCH) is a passive extruded heatsink with thermal interface. It is attached using a clip with each end hooked through an anchor on the Heatsink Stiffener attached to the board. Figure 6-4 and Figure 6-4 show the reference thermal solution assembly and associated components.

Full mechanical drawings of the thermal solution assembly and the heatsink clip are provided in Appendix B.

6.5.1 Heatsink Orientation

Since this solution is based on a unidirectional heatsink, mean airflow direction must be aligned with the direction of the heatsink fins.

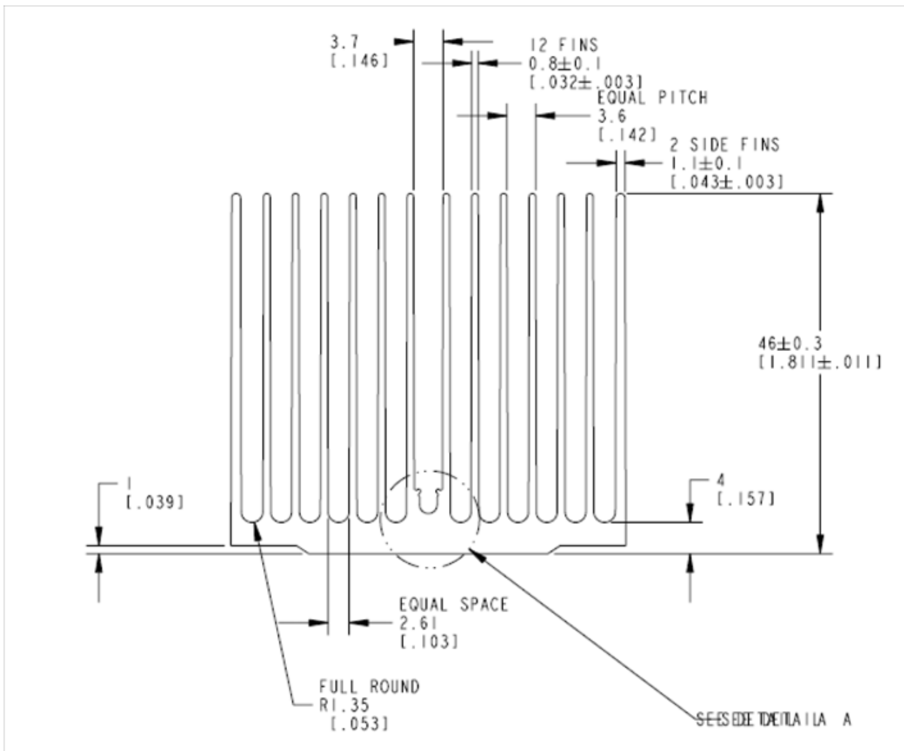
Figure 6-4. Intel 7300 MCH Heatsink Assembly



The reference thermal solution uses an extruded heatsink for cooling the chipset MCH. The heatsink stiffener and the backplate sandwich the motherboard through screws. This concept design is for reliability consideration both thermally and mechanically. See Appendix B for mechanical drawings of the heatsink stiffener and the backplate.

Figure 6-5 shows the heatsink profile. Other heatsinks with similar dimensions and increased thermal performance may be available. Full mechanical drawing of this heatsink is provided in Appendix B.

Figure 6-5. Intel 7300 MCH Heatsink Extrusion Profile



6.5.2 Mechanical Interface Material

There is no mechanical interface material associated with this reference solution.

6.5.3 Thermal Interface Material

A TIM provides improved conductivity between the IHS and the heatsink. The reference thermal solution uses PCM45 F, 0.25 mm (0.010 in) thick, 25 mm x 25 mm (0.984 in. x 0.984 in.) square.

Note: Unflowed or "dry" Honeywell PCM45 F has a material thickness of 0.010 inch. The flowed or "wet" Honeywell PCM45 F has a material thickness of ~0.003 inch after it reaches its phase change temperature.

6.5.3.1 Effect of Pressure on TIM Performance

As mechanical pressure increases on the TIM, the thermal resistance of the TIM decreases. This phenomenon is due to the decrease of the bond line thickness (BLT). BLT is the final settled thickness of the thermal interface material after installation of heatsink. The effect of pressure on the thermal resistance of the Honeywell PCM45 F TIM is shown in Table 6-2.

Intel provides both End of Line and End of Life TIM thermal resistance values of Honeywell PCM45 F. End of Line and End of Life TIM thermal resistance values are obtained through measurement on a Test Vehicle similar to Intel® 7300 Chipset Memory Controller Hub (MCH)'s physical attributes using an extruded aluminium heatsink. The End of Line value represents the TIM performance post heatsink assembly while the End of Life value is the predicted TIM performance when the product and TIM reach the end of their life. The heatsink clip of this reference design provides enough pressure for the TIM to achieve End of Line thermal resistance of 0.345 °C • in^2/W and End of Life thermal resistance of 0.459 °C • in^2/W.

Table 6-2. Honeywell PCM45 F TIM Performance as a Function of Pressure

Pressure on IHS(psi)	Thermal Resistance (°C × in^2) / W	
	End of Line	End of Life
2.18	0.391	0.551
4.35	0.345	0.459

6.5.4 Heatsink Retention Mechanism

The retention mechanism in this reference solution includes one wire clip, one heatsink stiffener, and one backplate.

The heatsink is attached to the chipset through the wire clip. Each end of the wire clip is attached to the heatsink stiffener. See Appendix B for a mechanical drawing of the clip.

The heatsink stiffener and the backplate sandwich the motherboard through 4 screws. This concept design is for reliability consideration both thermally and mechanically.A back plate and top side stiffener reduces the dynamic bending on the chipset meeting solder joint reliability goals & providing a robust mechanical solution. See Appendix B for mechanical drawings of the heatsink stiffener and the backplate.

Figure 6-6. Stiffener

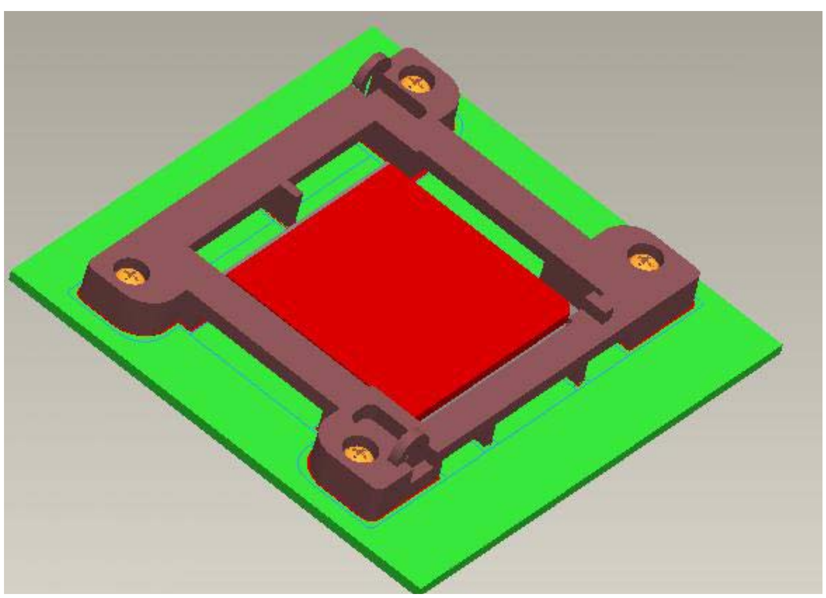
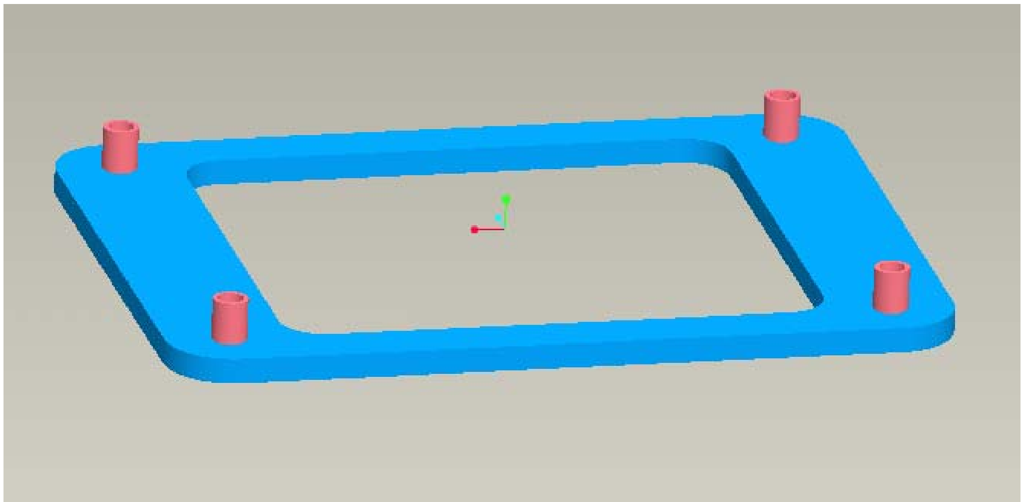


Figure 6-7. Backplate with Standoffs



6.5.4.1 Recommendations for Backplate and Top Side Stiffener

1. Add backplate and topside stiffener to the Intel® 7300 Chipset Memory Controller Hub (MCH) enabling solution in the Intel reference design because
   a. It meets solder joint reliability goals on the chipset (Intel tests MP chipsets to 7 year lifetime reliability criteria to meet the demanding requirements of high end server environment).
   b. It reduces the microstrain in the area of chipset package
   c. Its reworkable
   d. Its in compliance with the existing manufacturing requirement and procedure
2. Use a z-clip to attach heatsink to the stiffener because it provides mechanical support to the heatsink.

6.5.4.2 Solder Joint Reliability Goal and its Key Driver

Intel tests MP chipsets to 7 year lifetime reliability criteria to meet the demanding requirements of high end server environment. Key Driver in solder joint reliability (SJR) is Second level Interconnect

Second Level Interconnect/solder joint performance is a function of the following factors:

1. Board surface finish
2. Board Stiffness
3. Solder chemistry (Pb-free/Sn-Pb)
4. Dimensions of solder joints
5. Dynamic bending or strain forces (induced in manufacturing, drop & shipping conditions) depends on:
   a. Chassis Design
   b. Board Component Layout

c. Enabling components reactionary forces.

Intel recommends that customers do not exceed dynamic bending limit (1300ue)for the Intel® 7300 Chipset Memory Controller Hub (MCH) to maintain solder joint reliability requirements

6.5.5 Reliability Guidelines

Each motherboard, heatsink and attach combination may vary the mechanical loading to the component. Based on the end user environment, the user should define the appropriate reliability test criteria and carefully evaluate the completed assembly prior to use in high volume.

The test profiles for Intel® 7300 Chipset Memory Controller Hub (MCH) reference solution are unpackaged system level limits. The reference solution is to be mounted to a fully configured system. The environmental reliability requirements for the reference thermal solution are shown in Table 6-3 These could be considered as general guidelines.

Table 6-3. Reliability Guidelines

Test[1]	Objective	Inspection Guidelines[2]
Mechanical Shock	System level unpackaged Profile: 25G 2 drops in all 6 orientations	Visual Check and Electrical Functional Test
Random Vibration	System level unpackaged Duration: 10 min/axis, 3 axes Power Spectral Density Profile: 2.20g RMS	Visual Check and Electrical Functional Test
Thermal Cycling	-40 to 85, in conformance to JEDEC	Visual Check and Electrical Functional Test

Notes:
1. It is recommended that the above tests be performed on a sample size of at least twelve assemblies from three lots of material.
2. Additional inspection guidelines may be added at the discretion of the user.

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A Thermal Solution Component Suppliers

A.1 Heatsink Thermal Solution

Part	Intel Part Number	Supplier (Part Number)	Contact Information
CNB Heatsink_PCB_Assembly	D84075-002	AVC (S906Q00001)	Raichel Hsi Email: raichel_hsi@avc.com.tw Tel: 886-2-2299-6930 ext 7630
Heatsink/Clip Assembly	D64165-001	AVC (M0906Q000A)	
Backing Plate Assembly	D64159-001	AVC (A209000099)	
Stiffener Assembly	D97086-001	AVC(A232000082)	
Screw #4-40	Available with Assembly		

Note:
1. Contact the supplier directly to verify time of component availability.

A.2 Solder / Adhesive Suppliers

Part	Contact Information
T case TC's OSK2K1280/5SRTC-TT-T-40-72 pack of 5 Omega Eng	1-800-826-6342
Loctite 498 Adhesive (49850)	R. S. Hughes 916-737-7484
Loctite Accelerator (18490)	R. S. Hughes 916-737-7484
Solder Indium Corp. of America (57BI/42SN/1AG 0.010 Dia)	315-853-4900
Solder flux Indium Corp. of America (5RMA)	315-853-4900

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B Mechanical Drawings

Table B-1 Mechanical Drawing List lists the mechanical drawings included in this appendix.

Table B-1. Mechanical Drawing List

Figure B-1. Intel 7300 Chipset MCH Heatsink Assembly Drawing

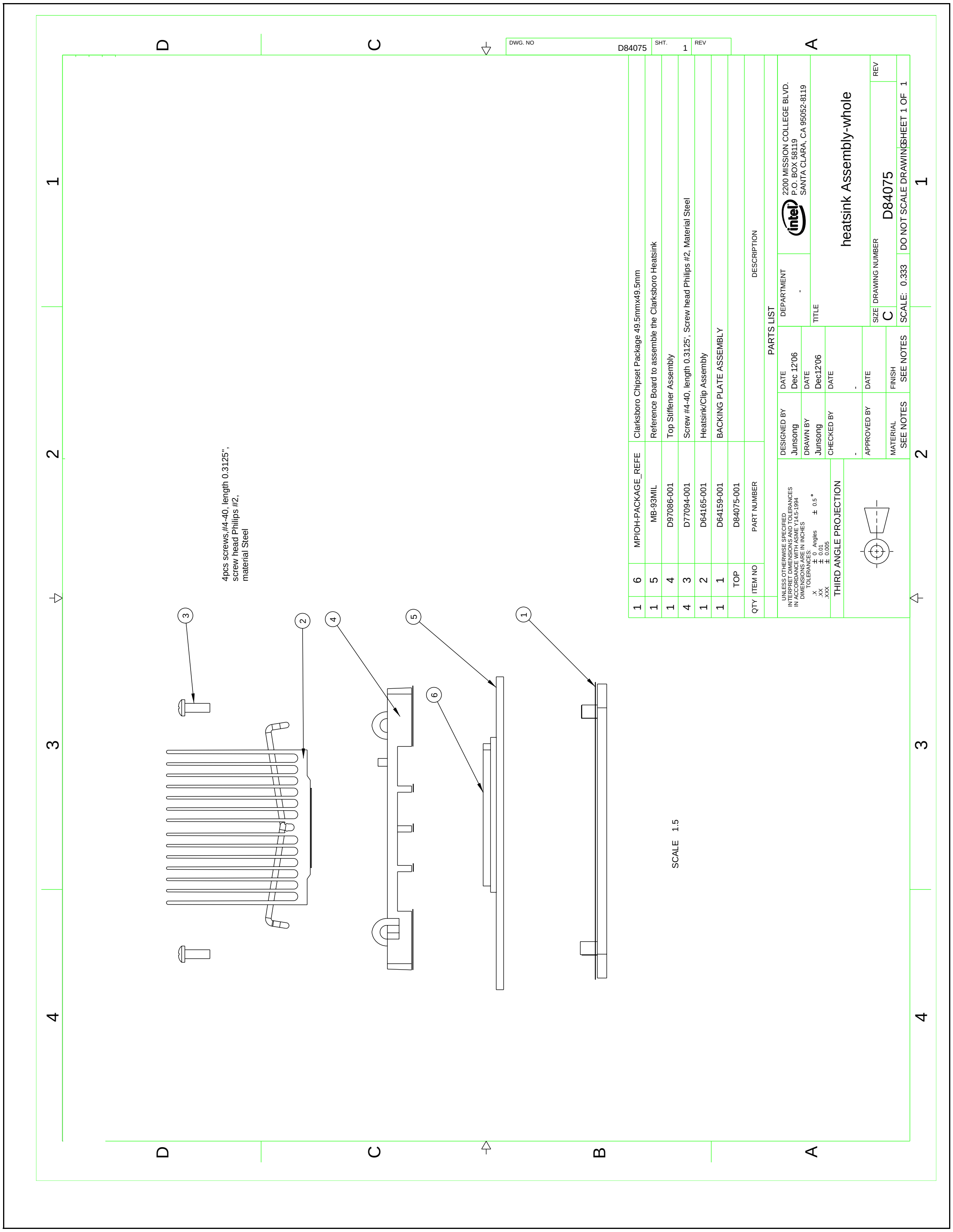


Figure B-2. Intel 7300 Chipset MCH Heatsink Drawing (1 of 3)

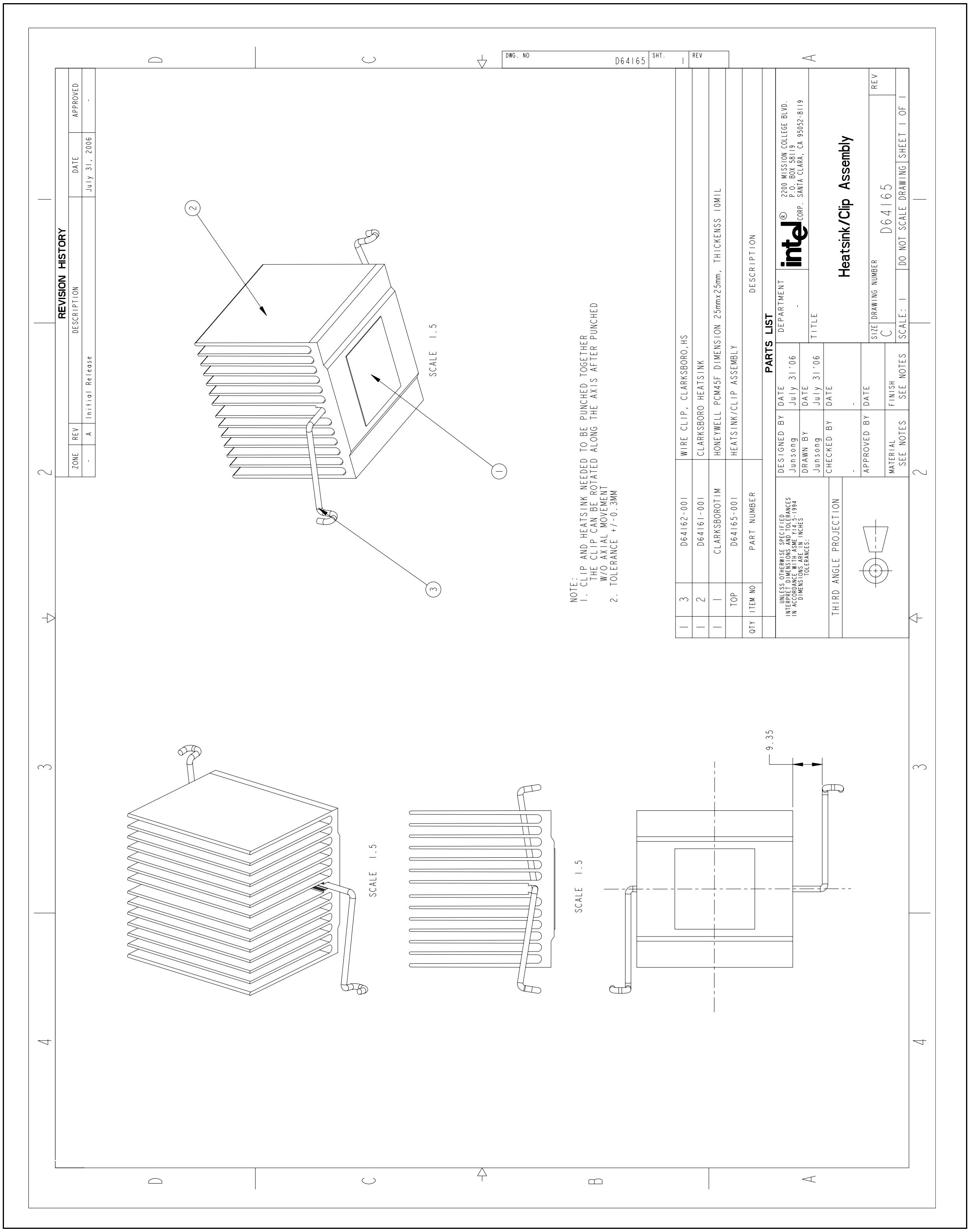


Figure B-3. Intel 7300 Chipset MCH Heatsink Drawing (2 of 3)

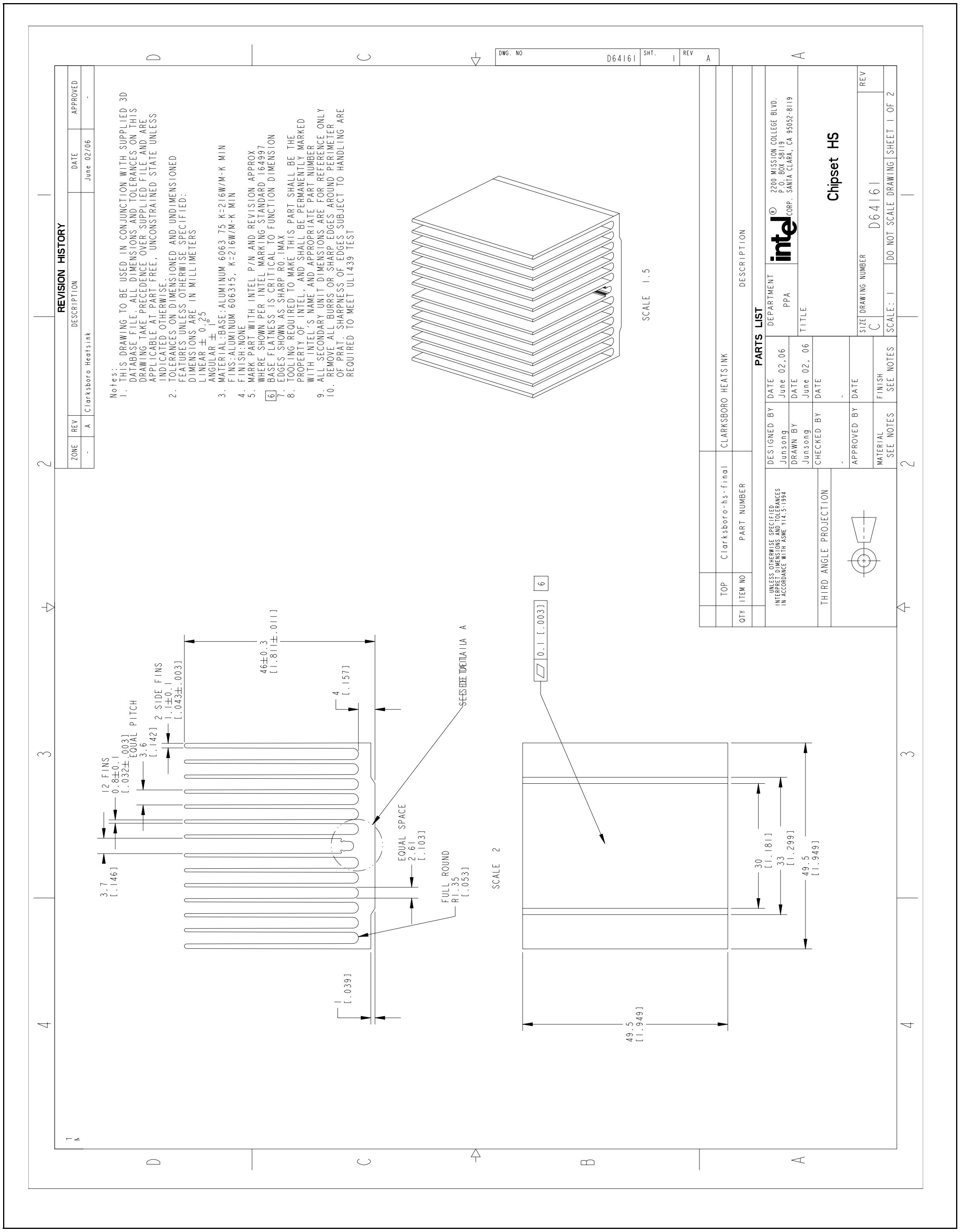


Figure B-4. Intel 7300 Chipset MCH Heatsink Drawing (3 of 3)

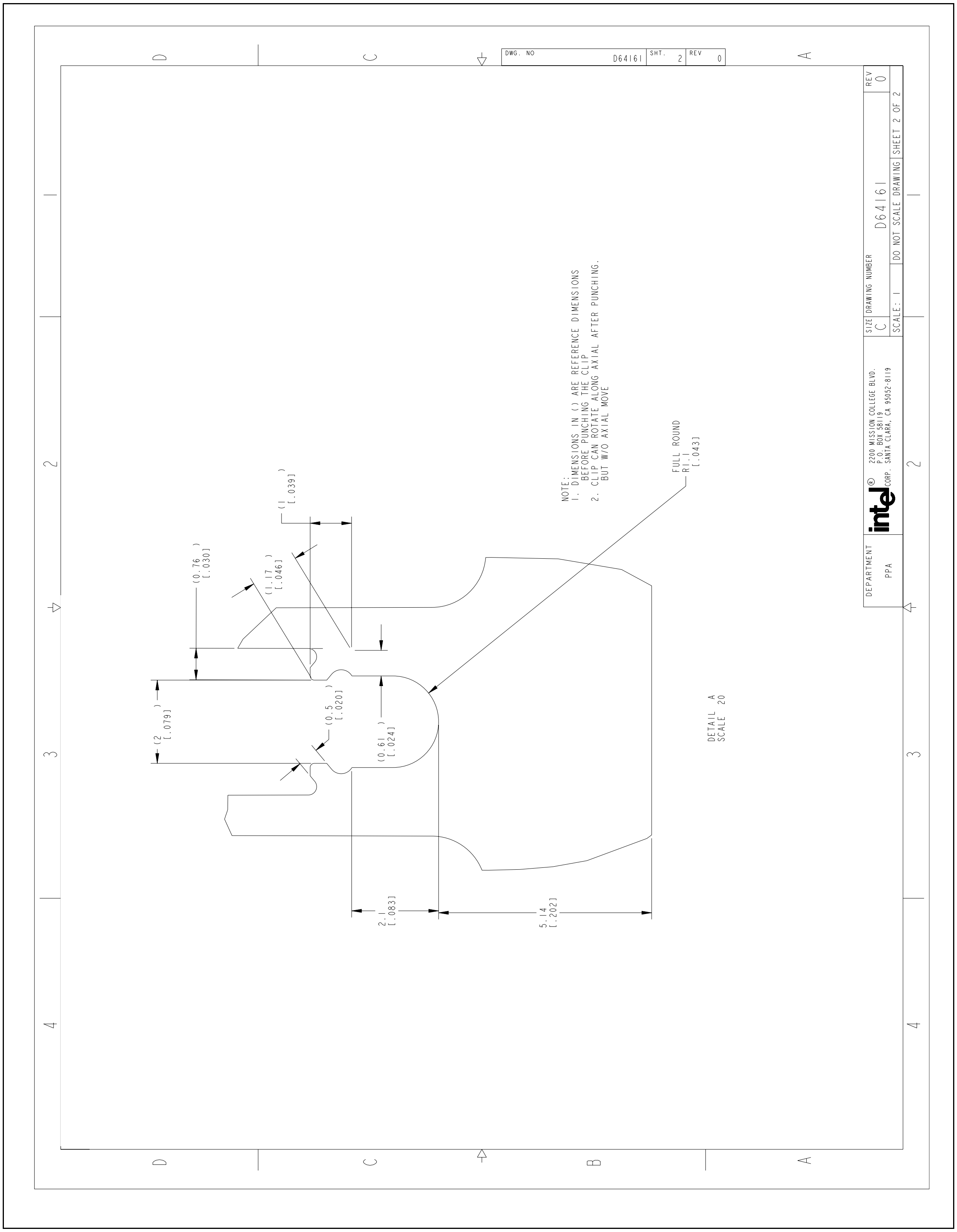


Figure B-5. Intel 7300 Chipset MCH Heatsink Wire Clip Drawing

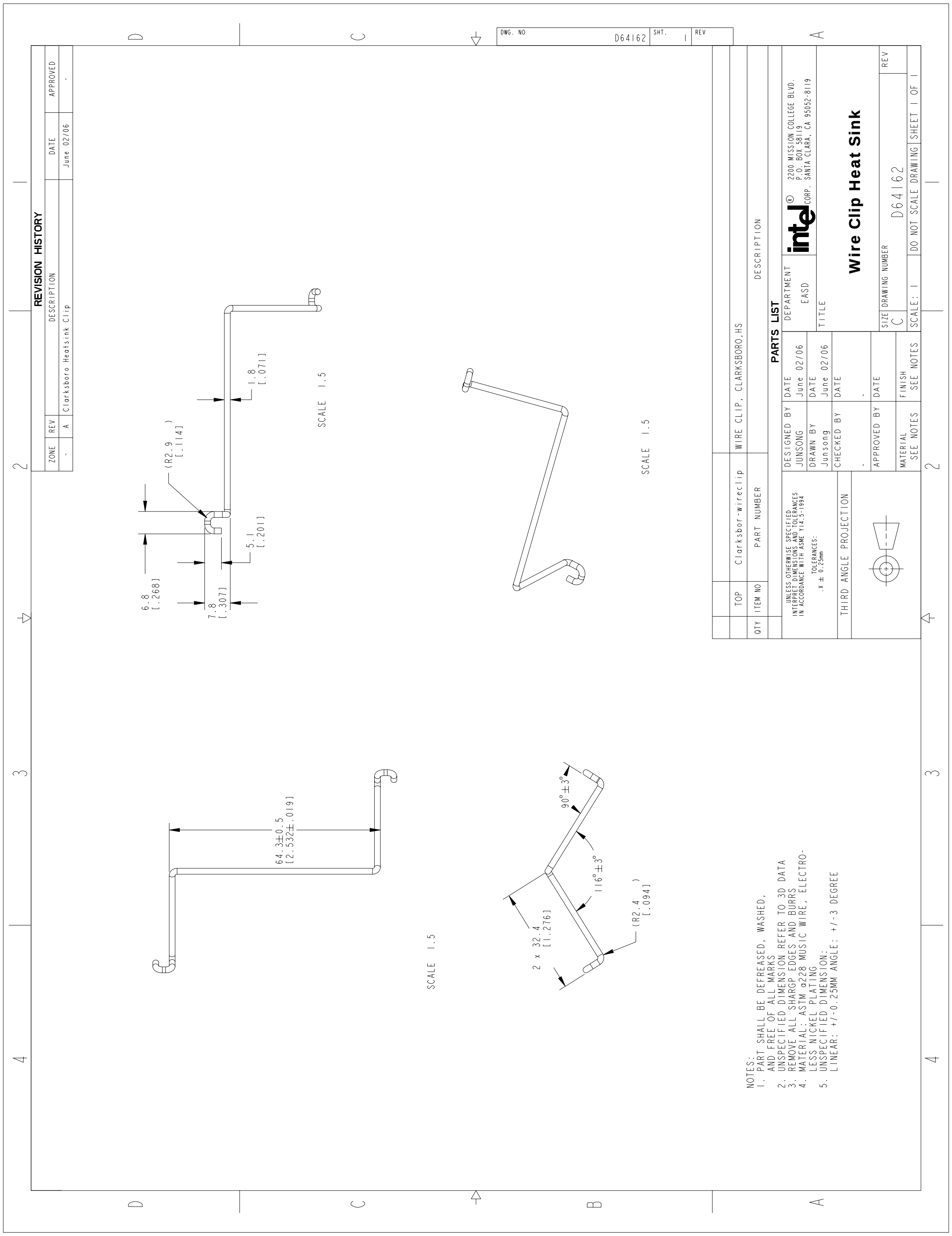


Figure B-6. Intel 7300 Chipset MCH Heatsink Backplate Insulator Drawing

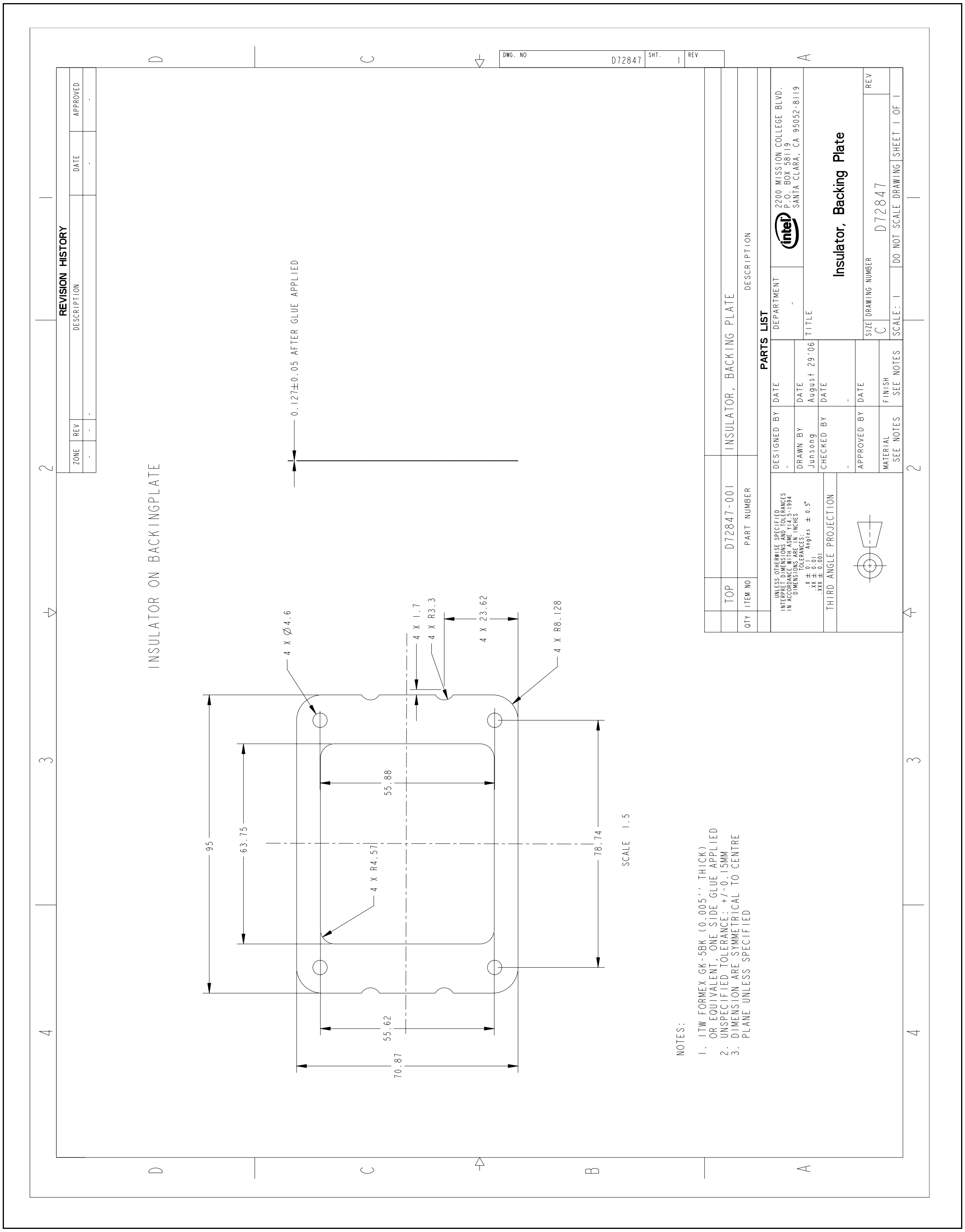


Figure B-7. Intel 7300 Chipset MCH Heatsink Backplate Drawing

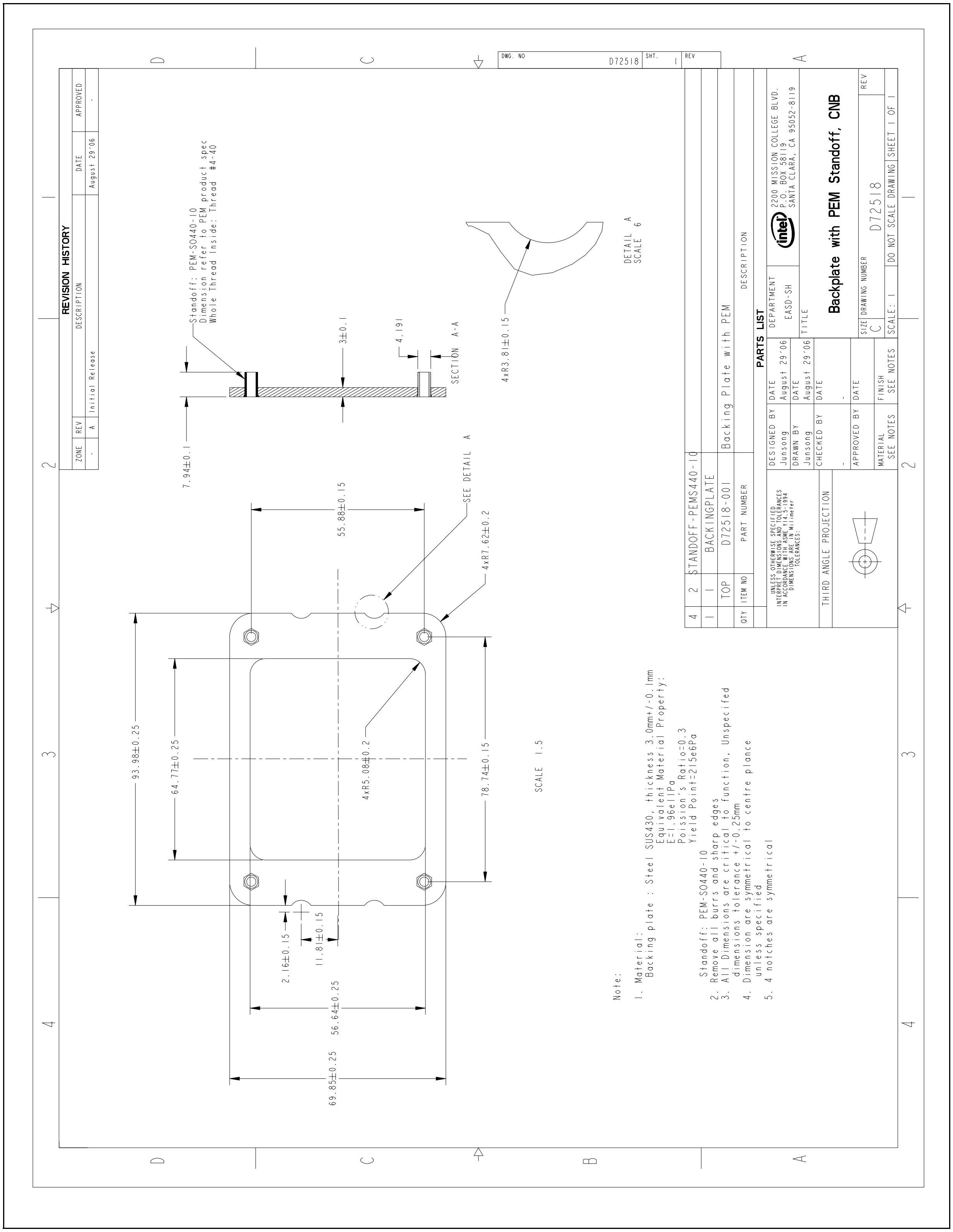


Figure B-8. Intel 7300 Chipset MCH Heatsink Backplate Assembly Drawing

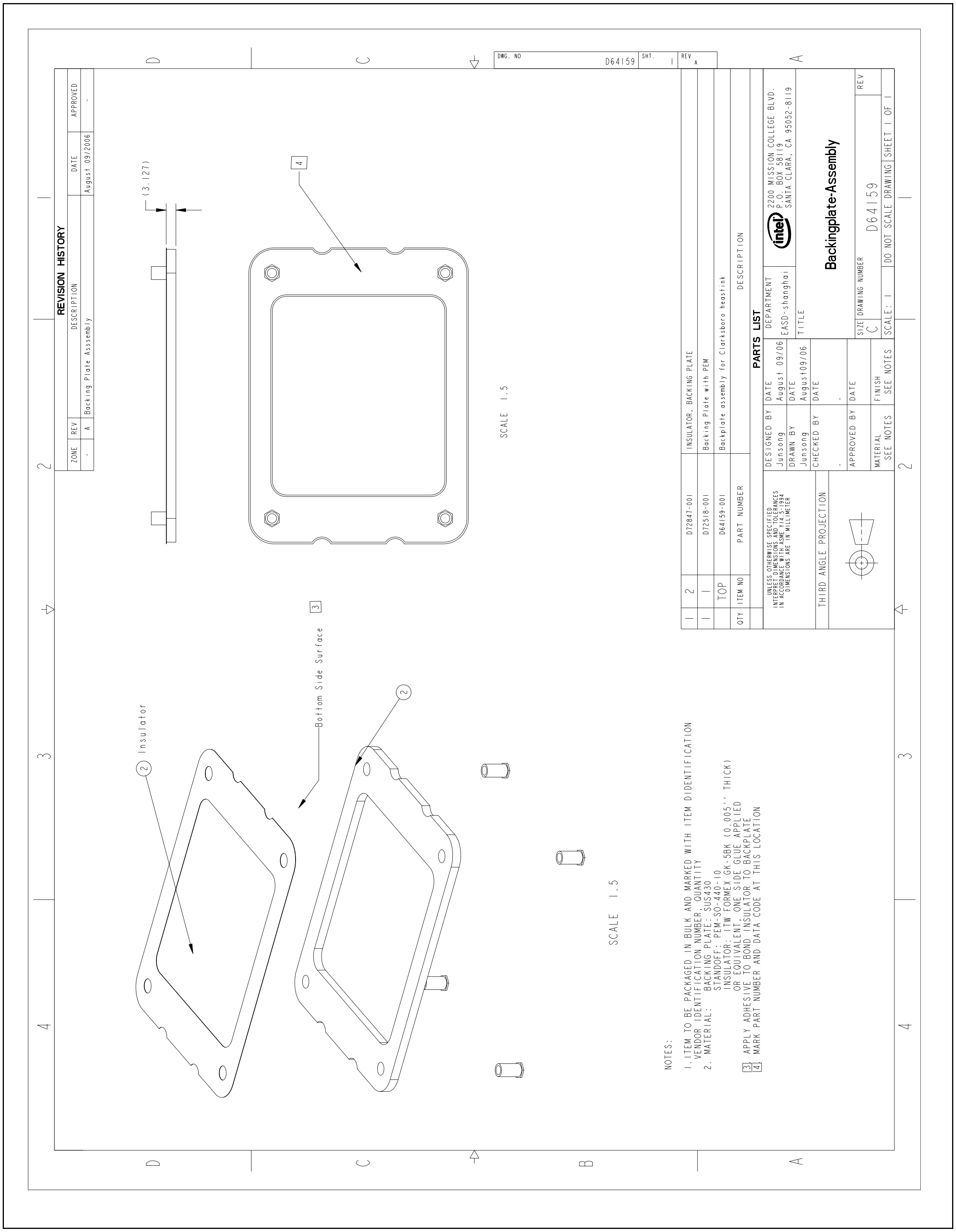


Figure B-9. Intel 7300 Chipset MCH Heatsink Stiffener Drawing (1 of 4)

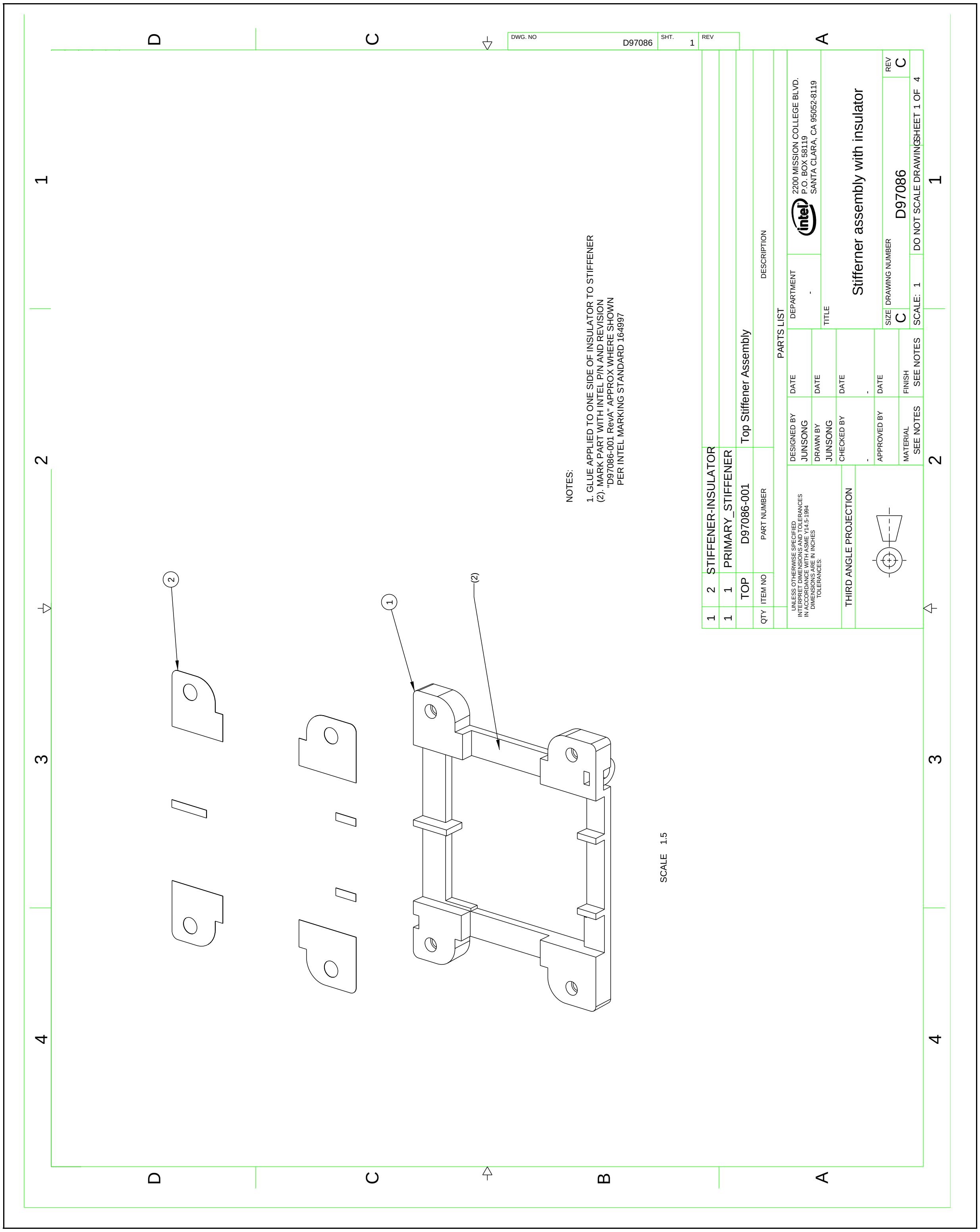


Figure B-10. CNB Heatsink Stiffener Drawing (2 of 4)

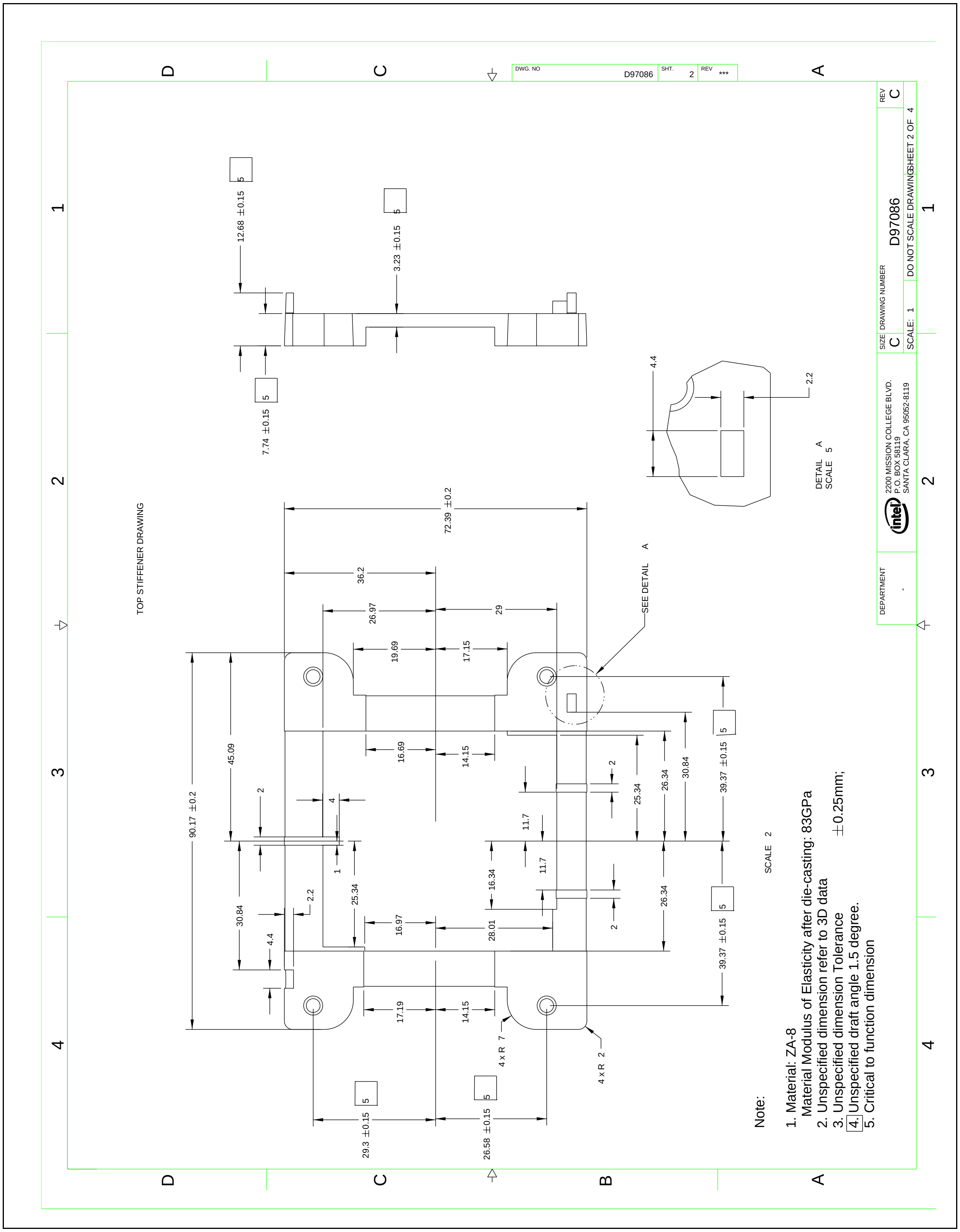


Figure B-11. Intel 7300 Chipset MCH Heatsink Stiffener Drawing (3 of 4)

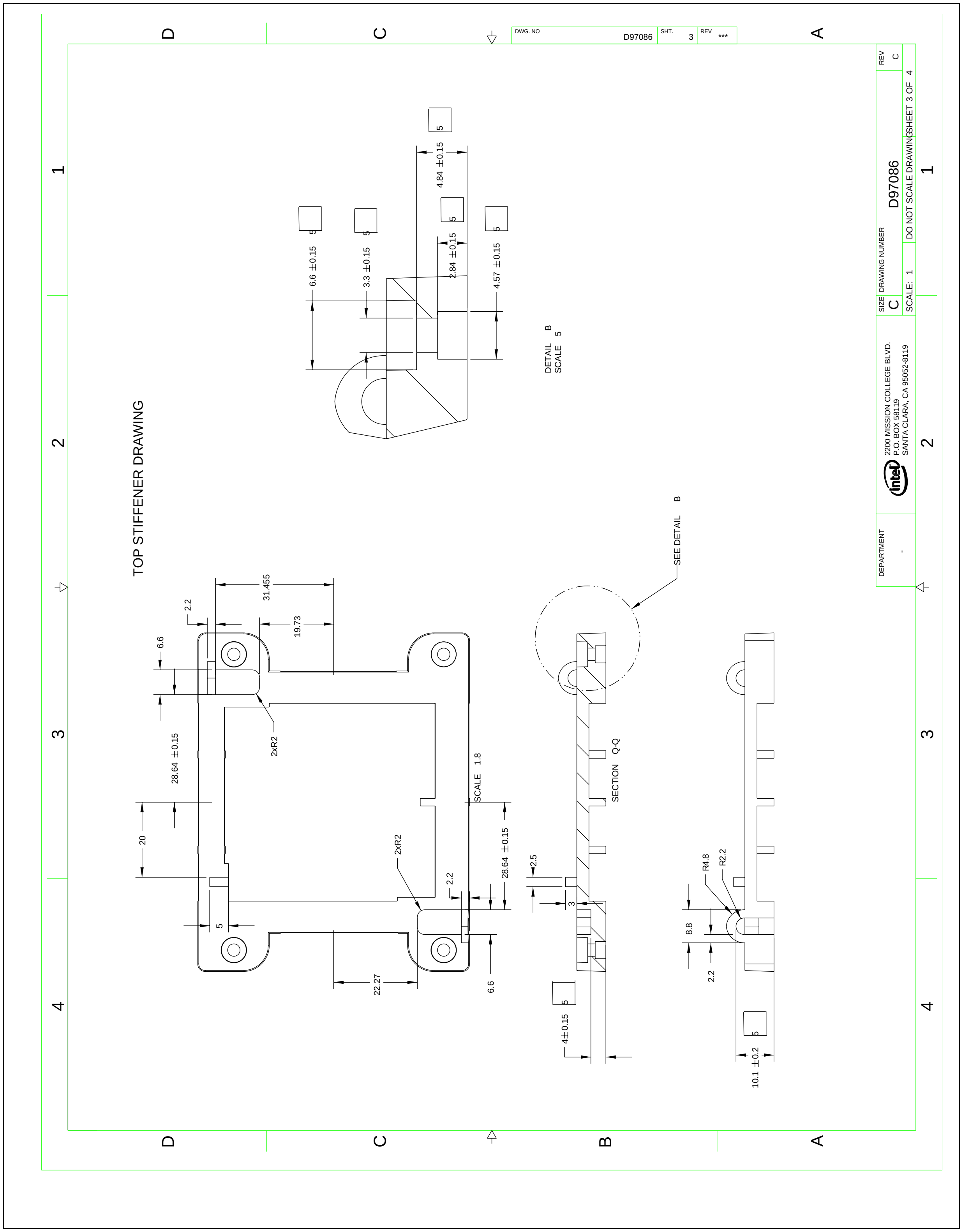


Figure B-12. CNB Heatsink Stiffener Drawing (4 of 4)

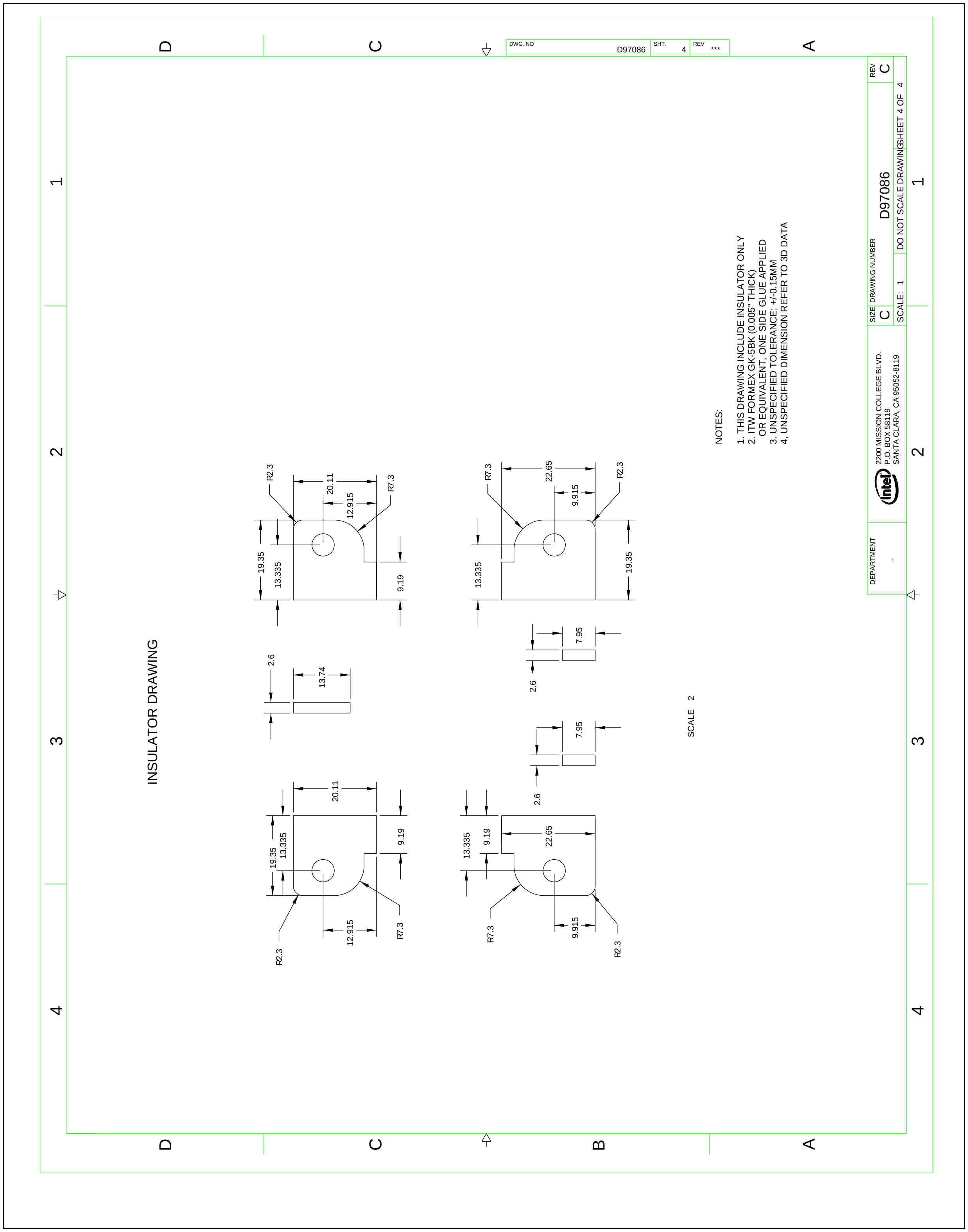
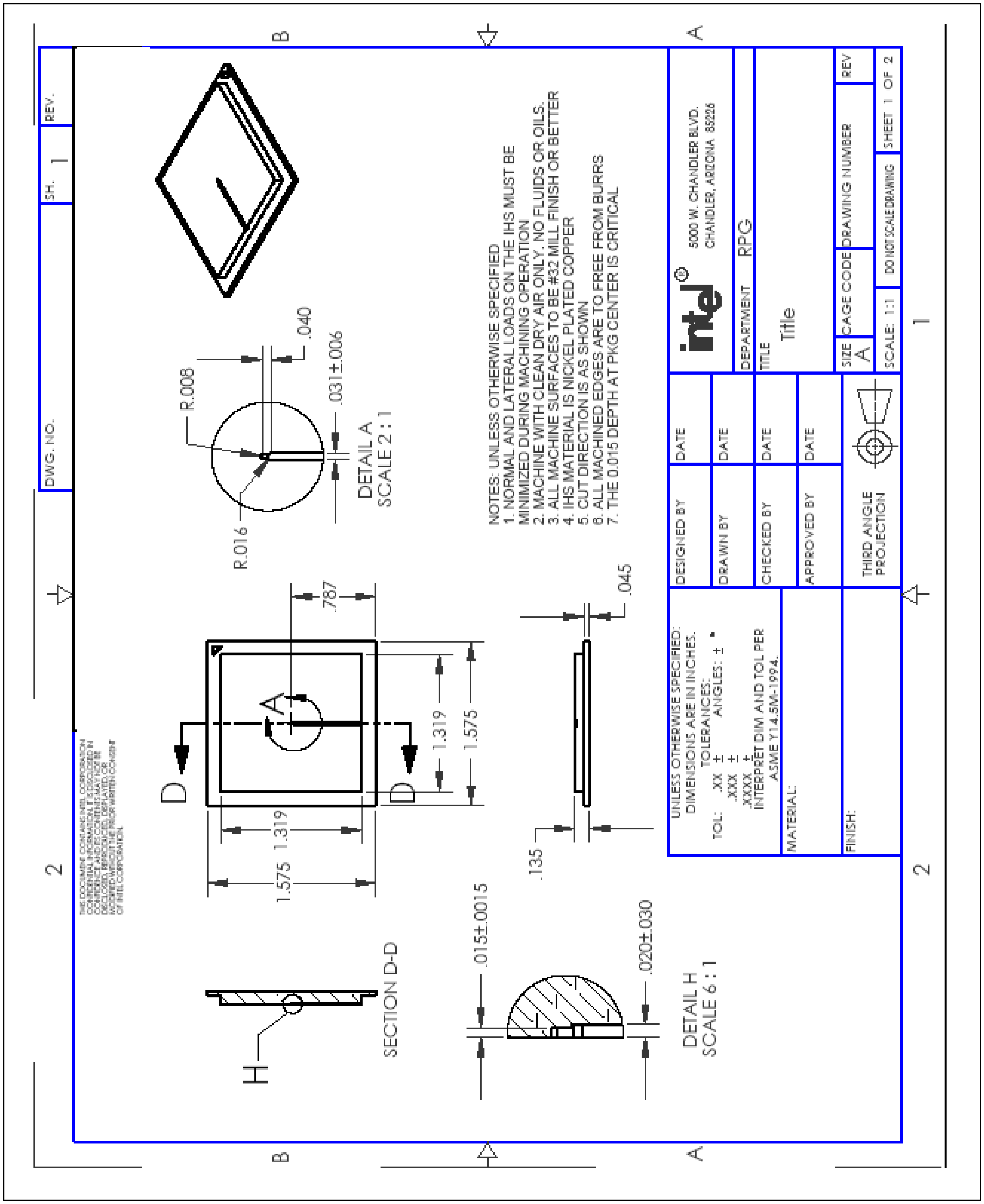


Figure B-13. I.H.S. Groove Drawing



B.1 Fixture Plate

A fixture plate should be used to machine the groove when installing on live boards.

Figure B-14. Fixture Plate (photo) (1 of 3)

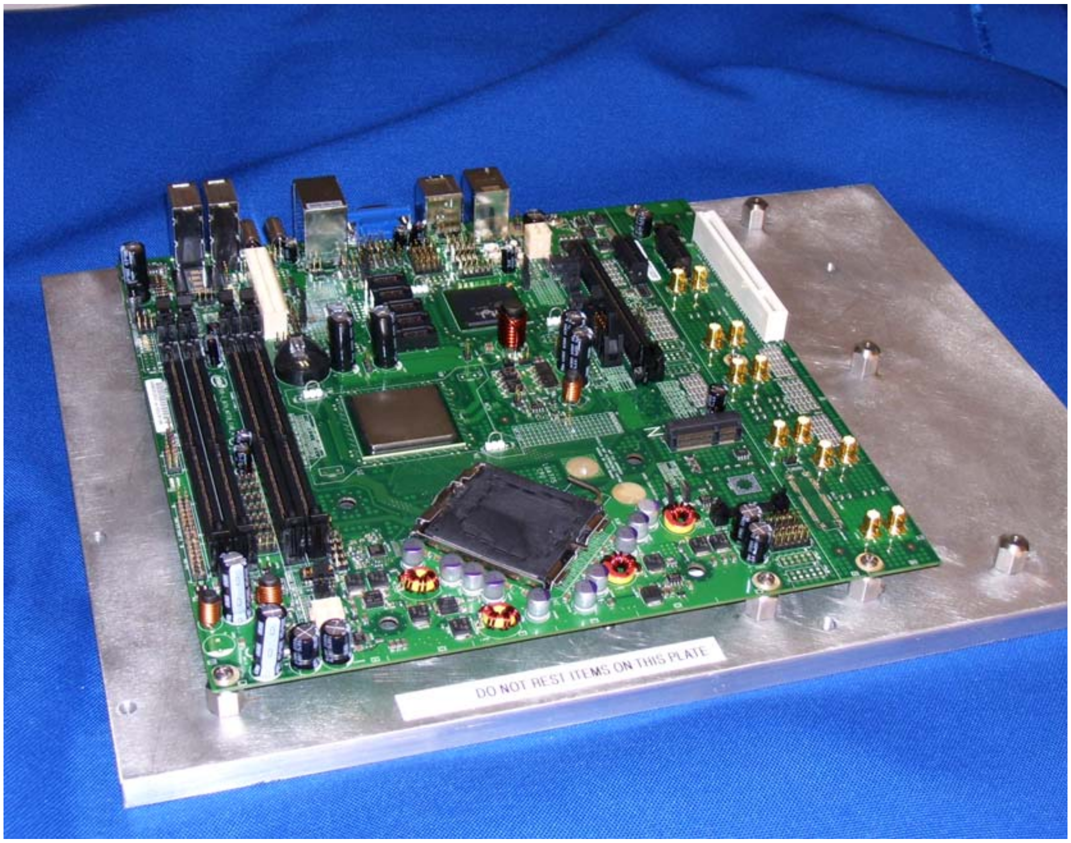


Figure B-15. Fixture Plate Drawing (2 of 3)

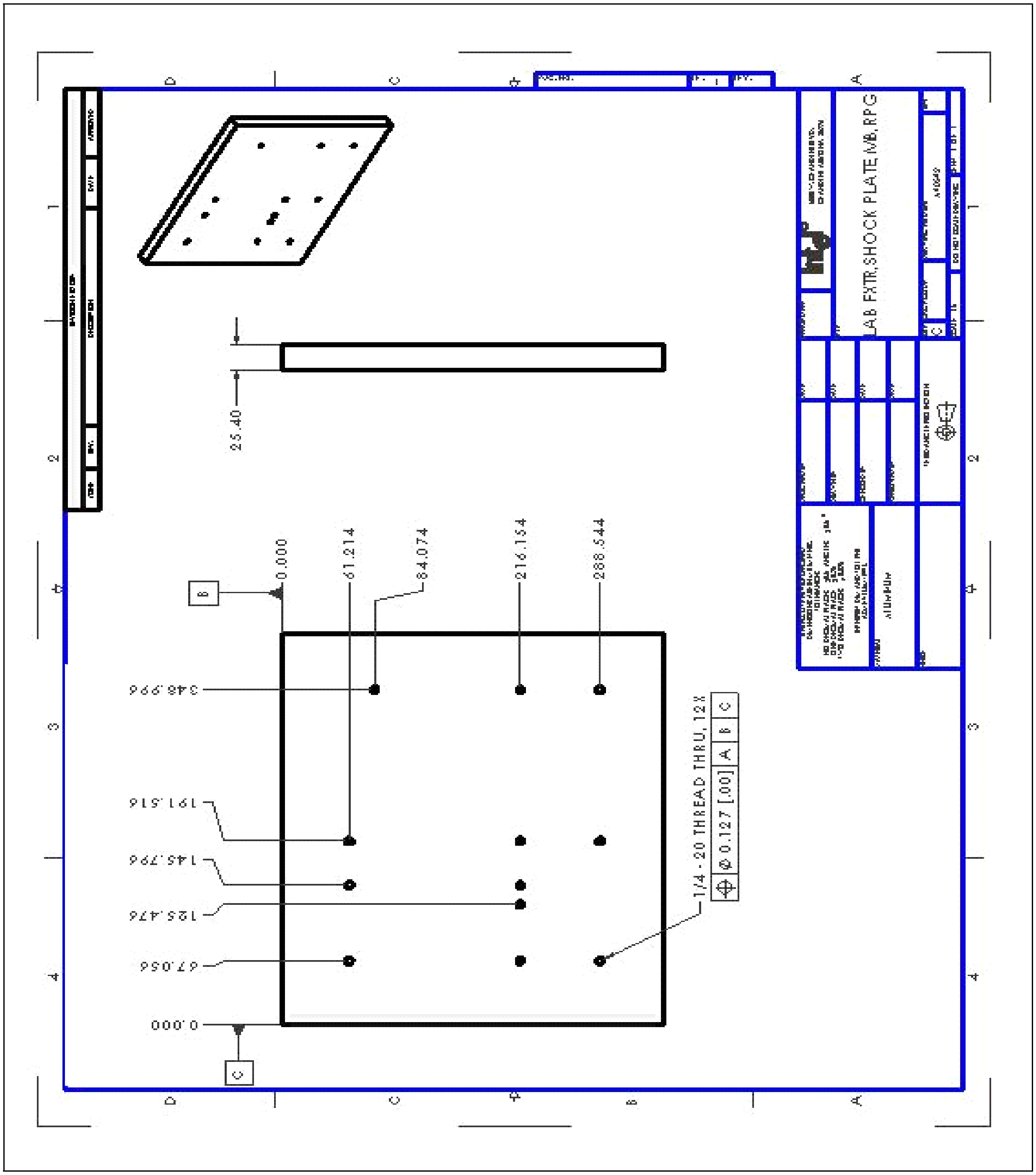


Figure B-16. TSTFXTR, Standoff, Shock Plate, DSKTP and ATX Drawing (3 of 3)

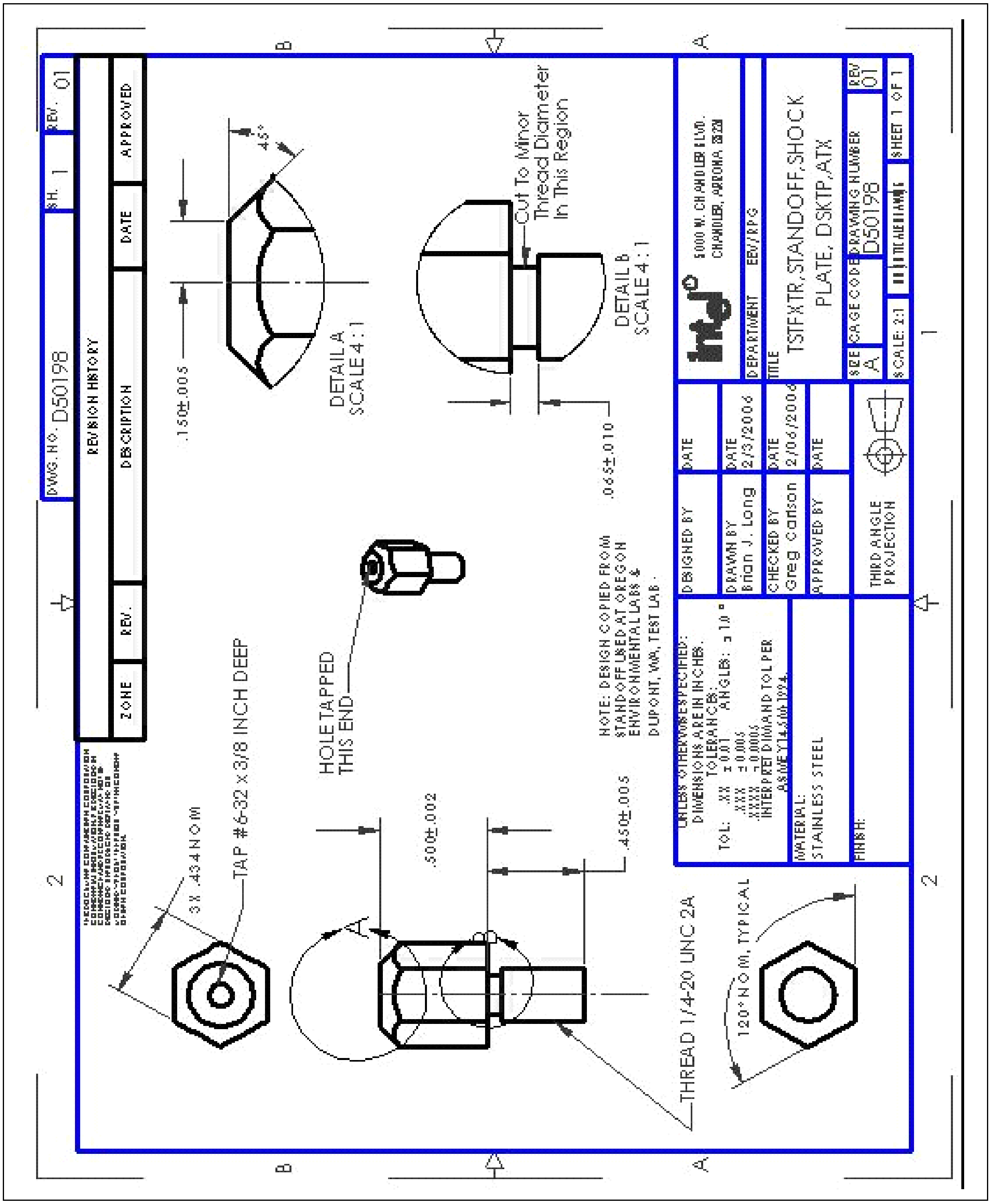


Figure B-17. Solder Tool and Block Drawing (1 of 4)

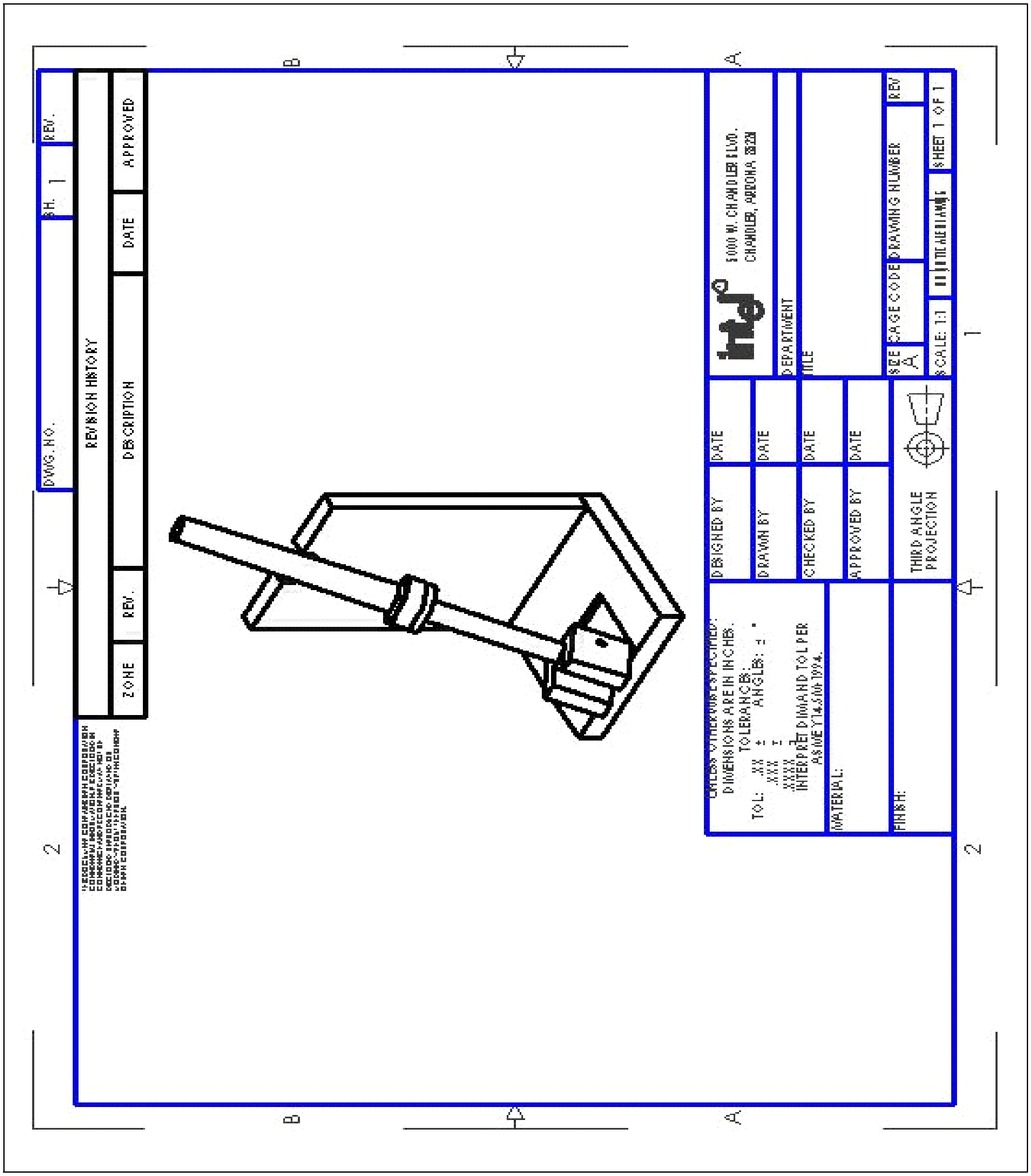


Figure B-18. CH Thermocouple Attach Stand Solder Iron Drawing (2 of 4)

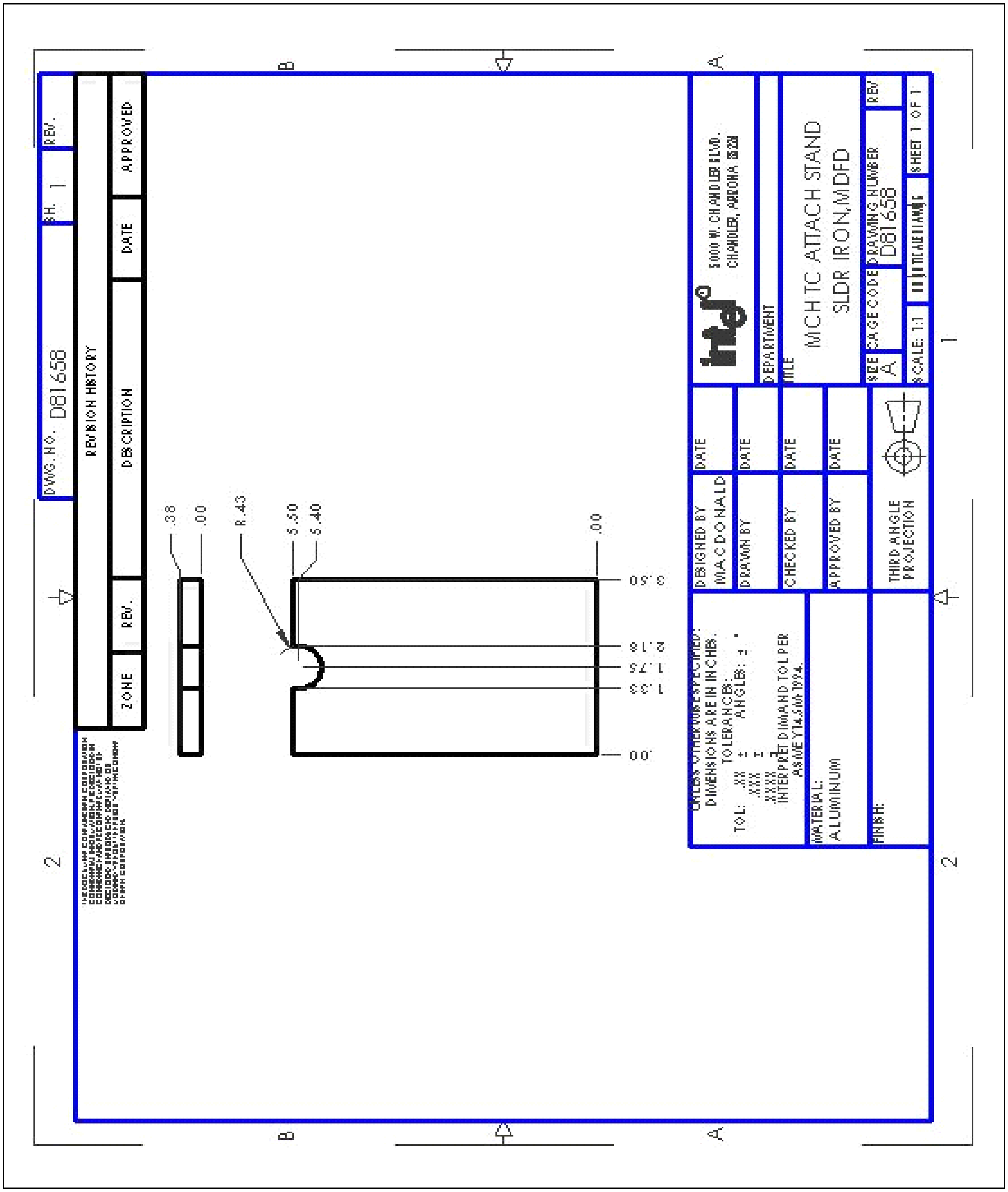


Figure B-19. IRON Block Solder Iron Drawing (3 of 4)

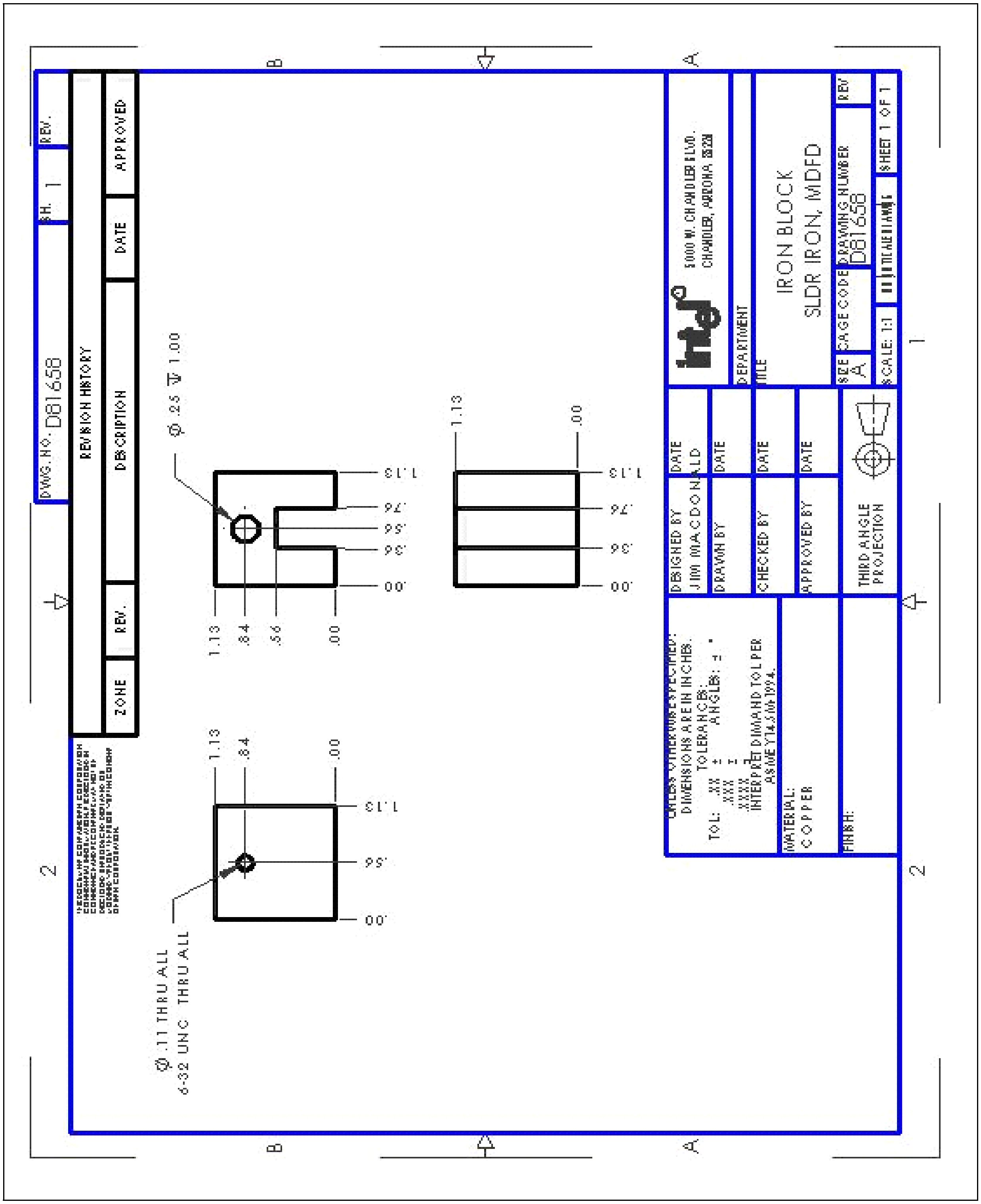
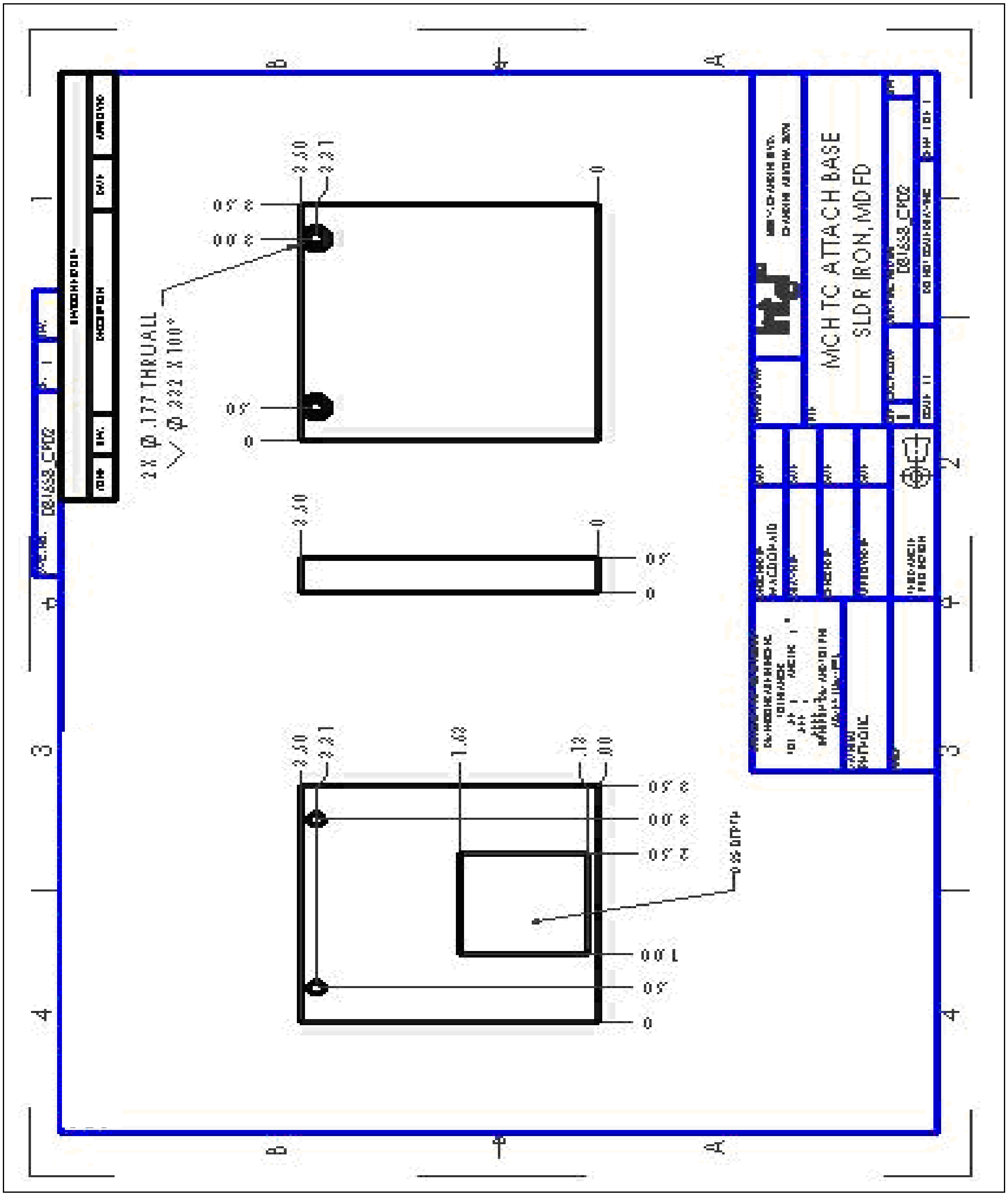


Figure B-20. MCH Thermocouple Attach Base Solder Iron Drawing (4 of 4)



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